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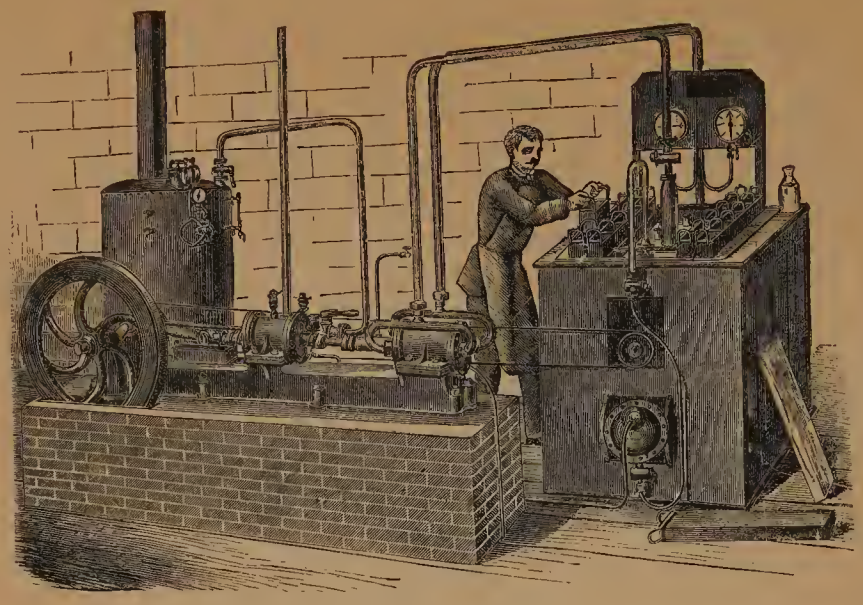

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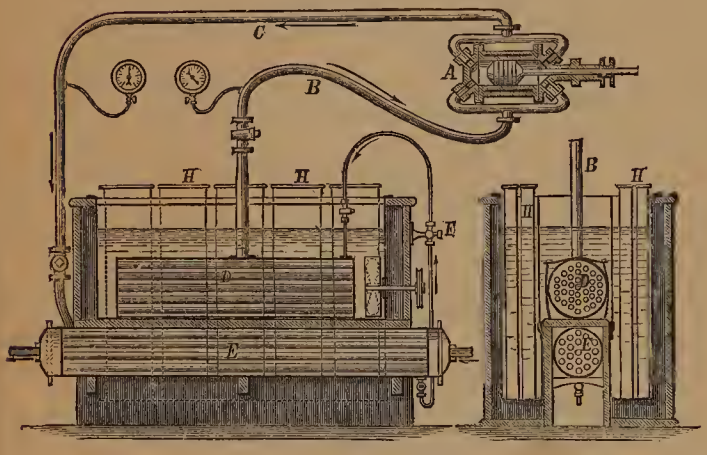

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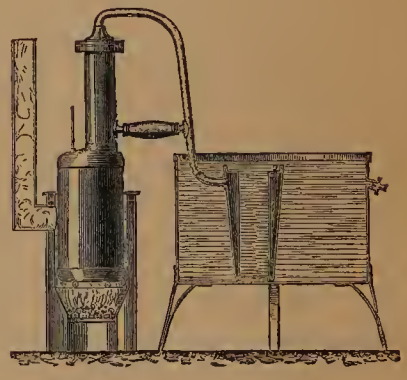

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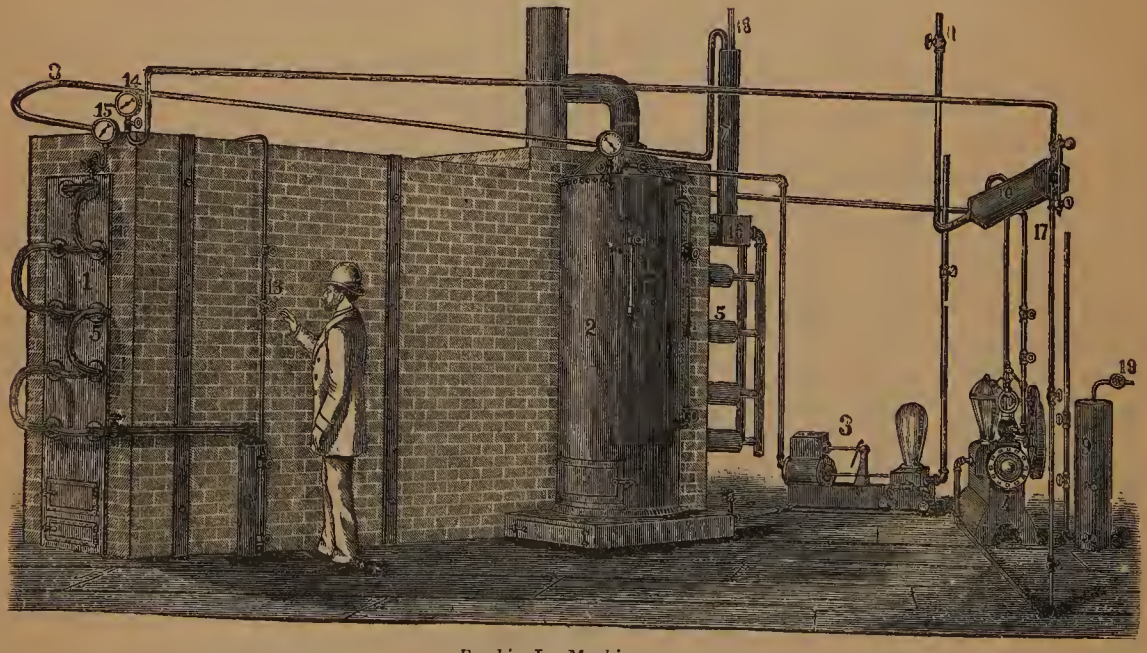

Rankin Ice Machine.

THE

PRACTICAL

DICTIONARY OF MECHANICS:

BEING

A DESCRIPTION OF TOOLS, INSTRUMENTS, MACHINES, PROCESSES, AND ENGINEERING; HISTORY OF INVENTIONS; GENERAL TECHNOLOGICAL VOCABULARY;

AND

DIGEST OF MECHANICAL APPLIANCES IN SCIENCE AND THE ARTS.

By EDWARD H. KNIGHT,

CIVIL AND MECHANICAL ENGINEER, ETC., U.S.

Illustrated

WITH UPWARDS OF TEN THOUSAND ENGRAVINGS.

DIVISION VIII.,

Being a Supplementary Volume (with Index References to Technical Journals 1876—1880).

"Thus Time brings all things, one by one, to sight,
And Skill evolves them into perfect light."

LUCRETIUS, Book V.

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spanner, the socket of which will fit the square on the pump-shaft. The transference of the liquid from the upper chamber to the space beneath the pistou is the cause of the elevation of the head and cylinder on the stem of the foot-piece.

Fig. 1414 represents the Dudgeon hydraulic jack. The vibrating lever *L* operates the plunger *D* by means of a cam, taking oil or glycerine from the chamber and forcing it by passages to the space *C* beneath the ram *B*, which rises in cylinder *A*.

The hydraulic jack has many applications, in machines bearing special names. See, among others: CRANK-PIN JACK, * Fig. 720, p. 229, *supra*; CAR-WHEEL PRESS, * Fig. 7189, p. 2768, "*Mech. Dict.*," etc. See list under HYDRAULIC MACHINERY, *infra*.

See: — *Dudgeon* * "*Amer. R. R. Jour.*," 1. 647.
* *Emery's Report*, "*Centennial Reports*," vi., Group XX., p. 37.
Compound, *Harrison*, Br. * "*Engineer*," xlii. 21.

Hy-drau'lick-ing. (*Mining.*) Washing down a placer claim by the use of hose or *giant nozzle*.

"The water is sold by the inch, that being the customary quantity which escapes through an orifice one inch square with the water 6″ deep above the top of the orifice; as measured, an inch of water is considered equal to 2¼′ cubic per minute. The mining ditches of California (1871) carry at least 100,000″, or about 2,500,000,000 gallons in 24 hours. This water is carried in open canals, in wooden frames, and iron pipes. The latter are used now invariably in crossing deep ravines, and the necessities of the positions have led to the adoption of heroic engineering precedents in regard to the thickness of metal, coupled with diameter of pipe. Thus the Swartsville pipe, 16″ diameter, under 180′ pressure, of No. 18 sheet iron, was laid in 1861, not painted inside, but painted on the out. San Juan, 30″ diameter, Nos. 12 and 14 iron, 55′ head, coated inside and out, laid in 1861. Chinese camp, Nos. 12, 14, 16, and 18 iron, maximum head 800′, was laid in 1868. The pipes are double rivcted on the longitudinal seams, put together like stove-pipes aud riveted, and coated with coal tar.

"Most of the water thus distributed is used, as is said, *to hydraulic*, that is, to wash banks of auriferous earth by throwing a stream of water upon them through a hose and pipe. Hydraulic claims are usually in hills. The water is brought to the bottom of the hill by an iron pipe or by a hose. The hose is of heavy duck, and from 4 to 10″ diameter, sometimes surrounded by iron rings 2″ wide and 3″ apart, connected by 4 ropes. It is important to preserve as great a head as possible, with flexibility of hose. The nozzles are like those of fire-engine hose, sometimes as large as 8″ diameter, with a discharge of 300 to 800″ of water. The miners usually turn the stream upon the banks near the bottom until a large mass of earth tumbles down. They then wash all this away into the sluice, and then cut the bank again at the bottom. The water usually costs 10 cents per inch per day, and dirt in this way has been in some places excavated at a profit when it contained one cent's worth of gold in a cubic foot. The same hydraulic process has been used for excavation merely."

See FLUME, Fig. 2041, p. 891, "*Mech. Dict.*"

Hy-drau'lic Lift. Lifting apparatus operating by pressure of water. See HYDRAULIC ELEVATOR; HYDRAULIC HOIST; HYDRAULIC PRESS.

Hy-drau'lic Lo'co-mo'tive. A device for traveling up a flume by power derived from the flow of water.

Leaman . . . . * "*Scientific American*," xxxvi. 79.

Hy-drau'lic Ma-chin'e-ry. Companies are now established in England for the production and renting of hydraulic power, distributed by mains. Such are the Chester and the Hull (Br.) Hydraulic Engineering Co.'s.

The application of hydraulic power to the lifting of passengers in hotels and stores, goods in warehouses, and factories; and also to the working of cranes, dock-gates, swing-bridges, elevating and tipping coal-wagons, etc., has become quite common in Britain and America. In the latter, either local pumps or the city mains are used; in Britain the same occurs, but there are also companies which rent power.

The subject has been considered, as to its history and the elaboration of its methods and applications, in a paper read by Sir W. G. Armstrong, before the *British Instit. of Civil Engineers*, 1877, reproduced in "*Iron Age*," xix., June 28, p. 3.

"In Hull (Br.) the system does not differ essentially from an ordinary water service, in which the necessary head of water is obtained by pumping direct into the mains against the pressure in an air-vessel or stand-pipe. The difference consists in the higher pressure employed — generally from 600 lbs. to 800 lbs. per square inch — and in the use of dead weight accumulators for maintaining a uniform pressure, and allowing for the variation in the rate of consumption of the water. In nearly all towns where a good pressure in the water maiu exists, the force due to the pressure is being utilized with great advantage for the working of cranes and hoists and other purposes, and the water is generally paid for at a rate per 1,000 gallons consumed. The pressure in the ordinary water mains of a city rarely exceeds 60 lbs. on the square inch, and it is obvious that if the pressure were increased to 600 lbs. on the square inch only one tenth of the water would be used to do the same amount of work, and the machiuery employed to utilize the power ueed be only one tenth the capacity. The higher pressurc also gives a greater speed and certainty of action.

"What the Hull Hydraulic Power Company have done is to lay a main of about a mile in length through the streets bordering the Old Harbor at Hull, in which are built most of the public wharves and warehouses of the city. This main is charged at a pressure of 600 lbs. on the square inch by pumping engines erected at a convenient spot on the line of main. Not the least important point in the value of such an undertaking is that the water being used exclusively for working machinery does not require to be of a quality necessary for domestic purposes, and there are but few towns where the supply of pure water is so ample that the utilization of inferior supplies is a matter of no moment.

"Any person on the liue of main requiring to use cranes, or hoists, or printing machines, hydraulic presses, etc., has thus at his door a simple and economical power available at any moment by paying only for the amount he actually uses. In fact, the consumer can buy his power in the same way as he buys his gas, and with no more trouble in the one case than in the other. There are several other advantages in the system which will at once occur to the reader, such as the reduction of the risk of fire in warehouses through the substitution of water for steam power, and the saving of room effected by dispensing with boilers and engines. The water mains required for the system, though of great strength, are not of large size. The main laid at Hull is 6″ in diameter, which will be ample for all requirements there, aud would probably be seldom exceeded should the system ever come to be adopted in the largest cities of the kingdom. Two pairs of pumping engines, of 60 horse-power each, have been erected, and the engine-house has been built to accommodate two other pairs of the same size, which will be added as the demand for the power increases. The engine-house is covered by a cast-iron tank, into which the water is pumped in the first instance from the river, and allowed to settle before being pumped into the main. A minimum charge is to be paid by consumers according to the size of the machinery to be worked, amountiug for an ordinary river-side warehouse crane to about £52 per annum; and the cost of working will amount to about ½d. for each ton lifted 40′."

Hull, Br. . . . . "*Engineering*," xxii. 279.
Accumulator, *Best* & *Marshall* . . . . * "*Eng. Mechanic*," xxvii. 455.
* "*Sc. American Sup.*," 3659.
Grimshaw . . . . * "*Iron Age*," xxi., June 20, p. 7.
Kingston-upou-Hull . "*Van Nostr. Mag.*," xviii. 211.
Kimely . . . . . * "*Scientific Am.*," xxviii. 127.
Merdach, Fr. . . . "*Iron Age*," xvii., Jan. 13, p. 9.
Tweddell, Br. . . . . * "*Engineer*," xliv. 98.
* "*Engineering*," xxvi. 271.
* "*Man. & Builder*," xii. 105.
* "*R. R. Gazette*," viii. 563.
Air pump, *Van Pauwel* . * "*Man. & Builder*," ix. 142.
Brake.
Barker, Midl. Ry., Br. . * "*Engineer*," xliii. 302.
Bridge opener, Harlem . * "*Man. & Builder*," xi. 6.
Car propeller, *Rosseau* . * "*Scientific American.*"
Compressor for gun carriages, *Krupp* . . * "*Engineering*," xxviii. 37.
Rendell . . . . . * "*Engineering*," xxviii. 37.
Vavasseur . . . . * "*Engineering*," xxviii. 37.
Crane, 160 ton . . . . * "*Engineer*," xli. 168, 170.
Fielding & Platt, Br. . * "*Engineer*," xliv. 88.
Mills, Br. . . . . * "*Engineering*," xxiv. 134.
Tweddell, Br. . . . * "*Engineer*," xliv. 98.
Dumping . . . . . * "*Sc. American Sup.*," 2437.
Elevator, *Burden* . . . * "*Man. & Builder*," xvi. 265.
Otis . . . . . * "*Man. & Builder*," xi. 221.
Tweddell . . . . . * "*Engineer*," xliv. 98.
Engine, *Knecht* . . . . * "*Sc. American*," xli. 278.
Richardson . . . . * "*Sc. American*," xxxvi. 262.
Hydrant, *Root* . . . * "*Iron Age*," xx., Oct. 25, p 1.
Rotary, *Root* . . . * "*Min. & Sc. Press*," xxxvi. 353.
Schmid, Switz. . . . * "*Engineer*," xlvi. 210.
* "*Sc. American*," xxxix. 327.
Forging, *Haswell*, Aust. *Thurston's* "*Vienna Report*," iii. 335.

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Grid . . . . . * "*Sc. American*," xl. 241.
Gun carriage, *Kaskazoff* . * "*Engineering*," xxiii. 305.
Hoist, marine slip . . . * "*Sc. American*," xxxvii. 130.
Docks, Br. . . . . * "*Sc. American Sup.*," 1696.
Marillier, Br. . . . . * "*Engineer*," xliv. 350.
Jack, *Dudgeon* . . . . * "*Am. R. R. Jour.*," 1. 647.
Compound, *Harrison* . * "*Engineer*," xliii. 21.
Lift, *Cranston* . . . . * "*Min. & Sc. Press*," xxxvi. 305.
Cushing . . . . . * "*Man. & Builder*," xii. 198, 232.
River Weaver, Br. . . * "*Engineer*," 1. 157, 160.
Trocadéro, Fr. . . . * "*Engineer*," xlvi. 377.
Locomotive, *Leaman* . . * "*Sc. American*," xxxvi. 79.
Main . . . . . * "*Man. & Builder*," viii. 233.
Mill, sugar cane, *Berry* . * "*Engineering*," xxix. 204.
Mining, California . . . * "*Engineering*," xxiv. 409, 448, 485.
Bowie . . . . . * "*Sc. American Sup.*," 1683.
* "*Sc. American*," xxxviii. 274.
"*Sc. American Sup.*," 757.
Distributor . . . . . * "*Min. & Sc. Press*," xxxv. 329.
Gravel elevator . . . * "*Min. & Sc. Press*," xxxiv. 377.
Nozzle . . . . . * "*Eng. & Min. Jour.*," xxiv. 169.
Gooseneck . . . . . * "*Engineering*," xxiv. 445.
Gravel mining . . . * "*Min. & Sc. Press*," xxxv. 329.
Hoskin . . . . . * "*Min. & Sc. Press*," xxxiv. 267.
" Dictator," *Hoskin* . * "*Engineering*," xxiv. 445.
Power Co., Hull, Br. . . "*Engineering*," xxii. 279.
Press, for gunpowder, Br. * "*Engineering*," xxv. 95.
Pump . . . . . * "*Sc. American*," xlii. 134.
Lyon . . . . . * "*Man. & Builder*," xii. 49.
Direct-acting, *Taylor* . * "*Engineering*," xxv. 190.
Pump, *Tweddell*, Br. . * "*Engineer*," xlv. 84.
Cotton, *Watson*, Br. . * "*Engineer*," xlv. 38.
Pumping eng., *Hathorn* . * "*Engineering*," xxiii. 488.
For mines . . . . . * "*Min. & Sc. Press*," xxxvii. 369.
Punch & shears, Toulon * "*Sc. American Sup.*," 1183.
Ram (8 Figures) . . . * "*Engineer*," xliv. 455.
Efficiency . . . . . "*Sc. American Sup.*," 239.
De Calichy . . . . * "*Engineer*," xli. 30
Easton & Amos . . . * "*Engineer*," xli. 30.
Fox . . . . . * "*Engineer*," xli. 30.
Fyfe . . . . . * "*Engineer*," xli. 30.
Heisse . . . . . * "*Scientific Amer.*," xli. 262.
Hett . . . . . * "*Sc. American Sup.*," 1262.
Hypsydre . . . . . * "*Engineer*," xli. 30.
Millington . . . . . * "*Sc. American*," xxxviii. 166.
Montgolfier . . . . * "*Engineer*," xli. 30.
Whitehurst . . . . * "*Engineer*," xli. 30.
Riveter, *Tweddell*, Br. . * "*Sc. American*," xxxiv. 226.
* "*Engineer*," xliv. 98.
Keel, *Tweddell*, Br. . * "*Engineering*," xxx. 535.
Shears, Toulon arsenal . * "*Engineer*," xli. 208.
Tweddell . . . . . * "*Sc. American Sup.*," 352.
Tip, wagon, *Thomson* . * "*Engineering*," xxviii. 204.
Valve, *Dennis*, Br. . . * "*Engineering*," xxviii. 13.

Hy-drau'lic Main Dip Reg'u-la'tor. A valve device in gas works for regulating the depth of seal of the dip-pipes in hydraulic mains. In *Isbell's* device an arrangement allows the heavy tar to be withdrawn from the bottom of the main without disturbing the seal. *Smith & Sayre Manufacturing Co.* See DIP-PIPE, Fig. 1660, p. 705, and GAS APPARATUS, p. 944, "*Mech. Dict.*"

Hydraulic main
* " *Manufacturer and Builder*," viii. 233.

Hy-drau'lic Mill. A form of sugar-cane mill in which the megass (*bagasse*) is steamed in a covered chamber and repressed in a second mill.

Sugar-cane mill, *Berry*, Br. . * "*Engineering*," xxix. 204.

Hy-drau'lic Mi'ning. A system of placer mining in which auriferous strata are washed down by water jets. See HYDRAULICKING; also HYDRAULIC NOZZLE, and references *passim*.

Hydraulic mining, Cal. . * "*Engineering*," xxiv. 409, 448, 485.
Bowie . . . . . * "*Sc. American Sup.*," 1683.
* "*Sc. American*," xxxviii. 274.
"*Sc. American Sup.*," 757.

Distributor, gravel mining.
* "*Min. & Sc. Press*," xxxv. 329.

Gravel elevator, *Cranston*.
* "*Min. & Sc. Press*," xxxiv. 377.

See also HYDRAULIC NOZZLE.

Hy-drau'lic Mo'tor. See HYDRAULIC ENGINE, "*Mech. Dict.*," *et supra*.

Hy-drau'lic Noz'zle. The pipe for directing a stream of water on a bank of auriferous gravel in placer mining.

The subject and the method are considered under HYDRAULICKING, *supra*; the flume of Smartville, California, is shown in Fig. 2041, p. 891, "*Mech. Dict.*," and the nozzles at Fig. 2616, p. 1149, *Ibid*.

" Monitor," Craig . . * "*Engineering*," xxiv. 445.
Fisher, Knuckle-joint . * "*Engineering*," xxiv. 445.
* "*Eng. & Min. Jour.*," xxiv. 169.
Gooseneck . . . . . * "*Engineering*," xxiv. 445.
Gravel Mining . . . * "*Min. & Sc. Press*," xxxv. 329.
Hoskin . . . . . * "*Min. & Sc. Press*," xxxiv. 269.
Dictator, *Hoskin* . . * "*Engineering*," xxiv. 445.

Hy-drau'lic Pile Driv'ing. (*Hydr. Eng.*) A mode of sinking piles in friable soil by means of excavating in advance of the pile by a forcible stream of water. See PILE, *infra*.

Hy-drau'lic Pow'er. See HYDRAULIC MACHINERY.

Hy-drau'lic Press. A press in which water under pressure of pump or elevation is used as a source of power. See p. 1149, "*Mech. Dict.*"

Beet root, Fr. . . . . "*Dep. Agri. Sp. Report*," No. 28, Plate XIV.
Lalouette . . . . . "*Dep. Agri. Sp. Report*," No. 28, Plate XV. Description on page 138.
Gunpowder, Br. . . . . * "*Engineering*," xxv. 95.
Press pump . . . . . * "*Scientific Amer.*," xlii. 134.
Lyon . . . . . * "*Man. & Builder*," xii. 49.
Direct acting, *Taylor* . . * "*Engineering*," xxv. 190.
Direct action pumps for,
Tweddell, Br. . . . . * "*Engineer*," xlv. 84.
Cotton press, *Watson*, Br. . * "*Engineer*," xlv. 38.

See also OIL PRESS; STEARINE PRESS; WIRE PRESS; HOT PRESS; also Plates XXIV., XXV., "*Mech. Dict.*"

Hy-drau'lic Pres'sure Pump. A pump for working a hydraulic press.

Knowles' pump, shown in Fig. 1415, works direct from the steam cylinder, dispensing with belt, pulley cranks and fly-wheel.

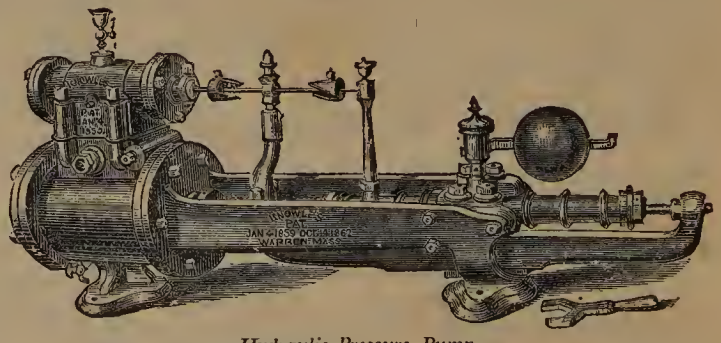
See also figures in Plates XXIV., XXV., "*Mech. Dict.*"

Hy-drau'lic Pump. 1. An engine for serving a line of pipes by which hydraulic power is distributed through a city or works. See account of works at Hull, Br., HYDRAULIC MACHINERY, p. 481.

2. A pump worked by hydraulic power.

3. A pump for serving a hydraulic press. See HYDRAULIC PRESSURE PUMP.

Fig. 1415.



Hydraulic Pressure Pump.

Pumping engine.
Hathorn & Co., Br. . . * "*Engineering*," xxiii. 488.
Water elevator for mines * "*Min. & Sc. Press*," xxxvii. 369.

Hy-drau'lic Punch. A punch operated by hydraulic power. See *G*, Plate XXV., opp. p. 1150, "*Mech. Dict.*"

Figs. 1416, 1417 show two forms of rail punches by Dudgeon. Fig. 1416 is for punching holes through the webs of rails, for the passage of the bolts of fish-plates. Fig. 1417 is for punching notches on the edge of the foot flange for the driving of the spike.

Punch and shears, Toulon, Fr.
* "*Sc. Am. Sup.*," 1183.

Fig. 1416.

Rail Web Punch.

Hy-drau'lic Rail'way Brake. A form of railway brake in which the rubbers are brought against the wheels by hydraulic power. Barker (Br.).

The brake in its early form was worked by a set of pumps in the guard's van driven by a friction wheel. As now used on the Midland Railway, a steam pump, fitted under the foot-plate of the engine, supplies a pressure which can be varied between 5 lbs. and 360 lbs. on the square inch. The pump starts of itself when the pressure falls below a certain point, and its duty consists in always keeping an accumulator filled, the load on the accumulator being supplied by the pressure in the boiler. The brake blocks are operated by small hydraulic presses.

Barker, Br.
* "*Engineer*," xliii. 302.
* "*Sc. Am. Sup.*," 1234.

Fig. 1417.

Rail Foot Punch.

Hy-drau'lic Ram. 1. A water-raising device, * p. 1150, "*Mech. Dict.*"

8 figures . . . . * "*Engineer*," xliv. 455.
Efficiency, etc. . . "*Scientific American Sup.*," 239.
De Calichy . . . * "*Engineer*," xli. 30.
Easton & Amos . . * "*Engineer*," xli. 30.
Fox . . . . . * "*Engineer*," xli. 130.
Fyfe . . . . . * "*Engineer*," xli. 160.
Heise . . . . . * "*Scientific American*," xli. 262.
Hett . . . . . * "*Scientific American Sup.*," 1762.
Hypsydre . . . . * "*Engineer*," xli. 30.
Millington . . . * "*Scientific American*," xxxviii. 166.
Montgolfier . . . * "*Engineer*," xli. 30.
Whitehurst . . . * "*Engineer*," xli. 30.

2. The piston of a hydraulic press.

The span of the Rock-island draw-bridge is rotated by two hydraulic rams, each of 10′ stroke and 5″ diameter of piston. These are placed over the circular girder of the turntable, one on each side of the span in a vertical position, and are worked by a double-cylinder engine, each cylinder 6″ × 8″. The force pumps are four in number, each with 1½″ piston. The rams are reciprocal, each being the reservoir for the other, and the office of the pump is to transfer the liquid (water .50, glycerine .50) from one ram to the other. Both the rams are thus under the same pressure at all times, and hold the span in equilibrium, except during the process of turning.

The power of the rams is transferred to the pier by means of a wire rope 1½″ diameter, arranged as in an Armstrong crane. See HYDRAULIC BRIDGE OPERATOR.

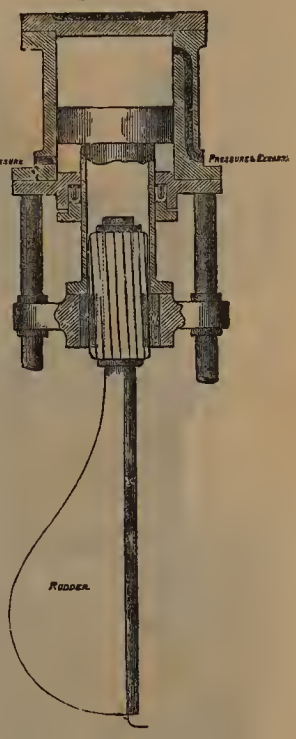
Hy-drau'lic Riv'et-ing Ma-chine. A machine riveter worked by hydraulic power. See Figs. 4351, 4354, p. 1949, "*Mech. Dict.*"

See also RIVETING MACHINE.

Hy-drau'lic Shears. Shears worked by hydraulic power. *O*, Plate XXIV., p. 1157, "*Mech. Dict.*" See also SHEARING MACHINE.

Hy-drau'lic Steer'ing Gear. Apparatus for working a rudder by means of hydraulic power. As seen in Lafargue's steering gear, the vertical action of the plunger contained in the power cylinder gives motion to a crosshead fitted with a nut having a screw cut of a quick pitch, the collar working in this being firmly keyed on to the upper end of the rudder, gives the circular motion required.

Fig. 1418.



Lafargue's Hydraulic Steering Gear.

* "*Engineer*,"
* "*Sc Am. Sup.*," 2253.

Hy-drau'lic Tip. A device for discharging coal wagons.

The invention of D. Thomson, of London. A vertical skeleton frame is provided with arrangements for lifting and tipping the wagons. A single hydraulic cylinder is used, the tipping being done by a chain attached to the end of the rising platform, that end of the platform being detained during the latter portion of the hoisting movement.

Thomson, Br . . . . * "*Engineering*," xxviii. 204.

See also HYDRAULIC DUMP.

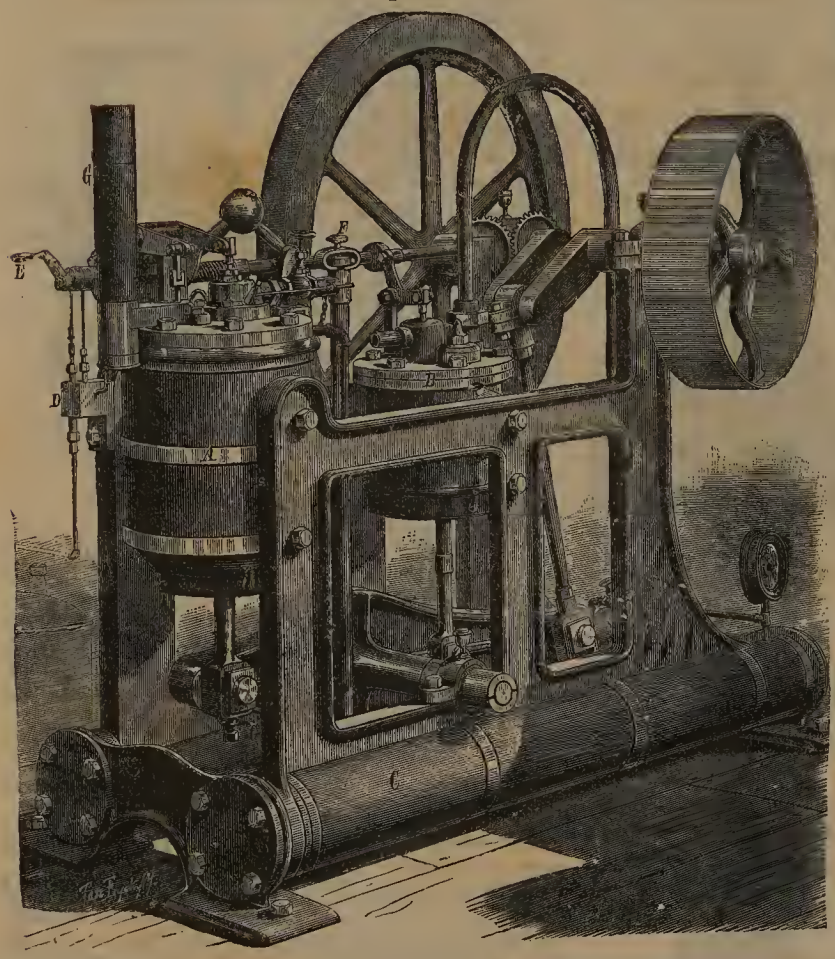
Hy-drau'lic Valve The valve for controlling the flow of water to and from the cylinder in hydraulic elevators; starting, stopping, and holding the car at the different floors. A wire shipping cable runs inside the hatchway from top to bottom, passing around the wheel on the valve stem, for opening or closing the valve, and the cable is under control of the attendant in the cage or on the platform. The valve is moved by pinion and rack and discharges below.

Fig. 1419.

Hydraulic Valve.

Dennis, Br. . . . . * "*Engineering*," xxviii. 13.

Fig. 1420.



Hydro-carbon Engine.

Hy'dro-ac-cu'mu-la'tor. See ACCUMULATOR; HYDRAULIC ACCUMULATOR, *supra.*

Hy'dro-car'bon En'gine. An engine in which mixed petroleum and air are burned to furnish power by the expansion due to combustion.

Fig. 1420 shows Brayton's single-acting hydro-carbon engine. *A* is the working cylinder of the engine, which is jacketed by a water cylinder. *B* is an air-pump actuated by the working cylinder, and employed to compress air into the two reservoirs *C C*, constituting the base of the frame. *D* is a pump, which supplies the petroleum or other suitable fuel, as fast as it is needed for combustion. The double-acting engine is furnished with a beam, the column carrying the beam center being employed as the reservoir for water. The air-pump is also double-acting, and is placed over the motive or working cylinder; the latter having a diameter of 10″ and 15″ stroke. The engine is constructed to stand a pressure of 100 lbs. on the square inch, and to make 200 revolutions per minute. The oil reservoir is formed in the frame supporting the crank shaft; but if the use of a reservoir of oil is objected to, the oil pump can draw its supply through a pipe from an oil tank placed at any convenient distance. One volume of crude oil can be burnt with 25 volumes of highly compressed air.

The action of the engine is as follows: The oil pump feeds a few drops of liquid fuel through a small tube into an annular chamber containing felt; here the petroleum encounters a supply of compressed air by which it is vaporized, the mingled air and vapor are forced in proper proportion into the working cylinder, where the combustion takes place, communication with the annular chamber being cut off and the products of combustion being left to work expansively, driving the working piston downward; towards the end of the stroke the compressed air supply to the working cylinder is cut off, thus extinguishing the combustion therein; the opening of the exhaust valve permits egress to the products of combustion, and the stroke is completed. An independent jet of hydro-carbon, burning continuously in a suitable chamber, lights the hydro-carbon in the working cylinder at the commencement of each stroke. The supplies of air and oil are adjustable, thus giving to the engines all the advantages of a variable cut off, and effecting an important saving in fuel when the engine is not required to work up to its full capacity. Ordinarily but one of the compressed air reservoirs *C C* is employed, the other being kept charged in order to allow of the immediate starting of the engine at any time.

The engine is made in sizes for small factories, for yachts, and launches: 3 to 10 horse power.

In the small horizontal petroleum engine of Julius Hock, of Vienna, the oil is pumped into one end of a cylinder, mixed with air, and then exploded, the piston is driven outward and returns by the momentum of the flywheel, forcing the gas out of an exhaust valve in the backward stroke. One end of the cylinder is open, like the Otto gas-engine.

Brayton.
* "*Engineer*," xli. 485.
* "*Engineering*," xxiii. 124.
* "*Sc. Amer. Sup.*," 916.
* "*Sc. Amer.*," xxxiv. 303; xxxvi. 15.
* "*Sc. Am. Sup.*," 529, 530.
Thomson, Sterne & Co., Br.
* "*Engineering*," xxvi. 46.
* "*Engineer*," xlvi. 42.

Hy'dro-car'bon Fur'nace. See PETROLEUM FURNACE.

Hy'dro-car'bon Oil. United States Revenue designations.

Lubricants: Semi-fluid oils of a tarry consistence at ordinary temperatures.

Paraffine oils: Fluid hydro-carbon oils below 36° *Beaumé.*

Kerosene: Fluid hydro-carbon from 36° to 59° *Beaumé.*

Benzine, from petroleum / *Benzole*, from coal } from 59° to 70° *Beaumé.*

Gasoline: From 70° to 80° *Beaumé.*

Hydro-carbon oils above 80° *Beaumé* volatilize in ordinary conditions of the atmosphere.

See PETROLEUM.

Hy'dro-cele Ap'pa-ra'tus. (*Surgical.*) Instruments for puncturing, syringing, or compressing the scrotum.

Pages 46, 47, Part III., *Tiemann's "Armamentarium Chirurgicum."*

Hy'dro-dy-na-mom'e-ter. An instrument employed to measure the velocity at any point of a liquid current. It determines directly the pressure exerted by the liquid against an obstacle to the current. This pressure is equilibrated by the torsion of a metallic rod. A graduated circle is used to measure the amplitude of the torsion.

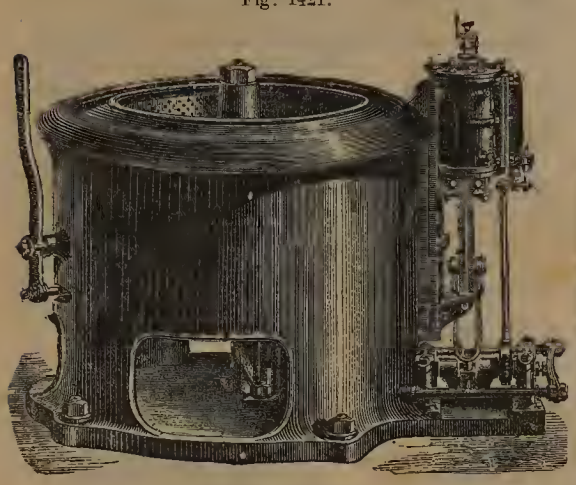
The account of *M. de Perrodil's* hydro-dynamometer,* translated from the "*Annales des Ponts et Chaussées*," in "*Van Nostrand's Eng. Magazine*," xvii., p. 481.

Hy'dro Ex-tract'or. Another name for a wringing or drying machine; the term especially belonging to the centrifugal dryer, known also as a centrifugal machine, sugar dryer, honey extractor, etc. See under the various heads in "*Mech. Dict.*," *et supra et infra.*

The instance shown in Fig. 1421 is one made by *Pierron & Dehaître*, Paris, in which a small and compact reciprocating steam-engine attached to the side of the shell operates the cage through the medium of shafts and bevel-gear. A similar arrangement is made by *Uhlinger*, of Philadelphia.

* "*Scientific American Supplement*" . . . . 2792.

Fig. 1421.



Hydro Extractor.

Hy′dro-gen Gas Ap′pa-ra′tus. For the production of hydrogen gas for aëronautic purposes.

Wet process, *Giffard* . . . . * "*Man. & Builder*," x. 36.
* "*Sc. Am.*," xxxviii. 104.
Super-heated steam, naphtha, and lime process, *Tessié du Motay* * "*Sc. Am. Sup.*," 3831.

Hy′dro-hem′o-stat. (*Surgical.*) A bag through which cold water is passed, and which is pressed against a surface to arrest hemorrhage.

Gouley's hydro-hemostat for arresting hemorrhage after lithotomy, is shown in Fig. 157 *c*, Part III., *Tiemann's* "*Armamentarium Chirurgicum.*"

Hy-dro-mère′. An *artificial mother*, or *hoverer*, heated by hot water, and designed for young chickens received from the incubator.

Hy-dro-mo′tor. An application of steam to pumping water, ejected at the stern as a mode of propulsion.

Hydro-propulsion was adopted by Rumsey, of Virginia. See p. 2322, "*Mech. Dict.*" The subject is considered under HYDRAULIC PROPELLER, p. 1150, *Ibid.*

* "*Scientific American*" . . . . . xli. 223.

Hy-dro-nette′. A portable force-pump for sprinkling gardens, flowers, and vines in conservatories, etc.

A syringe. See also AQUAPULT.

Fig. 1422.

Hydronette.

Hy′dro-pneu-mat′ic Ac-cu′mu-la′tor. An apparatus in which compressed air is made the reservoir of power; especially adapted for using in connection with hydrostatic presses and lifts. See ACCUMULATOR.

Hy′dro-pneu-mat′ic Gun. One in which the recoil is used to compress a volume of air, which, being subsequently brought to act upon the gun, shall raise it to the firing position.

The invention of Capt. Jas. B. Eads. Independently invented or adopted by Major Moncrieff. See description, pp. 506 *et seq.*, "*Ordnance Report*," 1877, and Plates XXXIX., XL.

Moncrieff's system. Described and illustrated in Barnard & Wright's report on "*Fabricating of Iron for Defensive Purposes*," Engineer Department, U. S. A., 1871.

Hy′dro-py-rom′e-ter. One in which the temperature is ascertained by exposing to the action of the heat which is to be measured a definite weight of some metal, as platinum, steel, copper, etc., and then quenching the same in a known weight of water, and noting the rise in temperature of the latter.

The plan was first adopted by Clement Desormes & Schwartz for the measurement of heat in furnaces; then by Regnault in the determinations of the specific heat of various substances, and by Dr. Siemens in experiments upon the varying electrical conductivity of telegraph wire under different degrees of temperature.

Byström's (Swedish) hydro-pyrometer, "*Ordnance Report*," 1878, Appendix R, 3, Plates IV., V., and p. 375.

Hy′dro-rhe′o-stat. An apparatus to vary the intensity of the electric current by passing it through water.

Fig. 360, Part I., *Tiemann's* "*Armam. Chirurgicum.*"

Hy′dro-stat. (*Electricity.*) Water stopper. The cell cover, which prevents the spilling or slopping of the exciting fluids, and which makes the battery portable, and enables the operator to convey it from place to place safely, without removing the liquid.

Hy′dro-stat′ic Joint. A leaden joint for mains, calked by hydrostatic pressure. A circular groove inside the bell of the main is occupied by a ring of lead. A threaded hole is made on the exterior, leading into the groove. Tar is poured in around the ring and force applied, which drives the lead into every crack. The hole is then fitted with a screw plug.

* "*Scientific American Supplement*" . . . . 1725.

Hy′dro-stat′ic Reg′u-la′tor. 1. The hydrostatic regulator, as applied by M. Cheret to the arming press (*balancier*) of the French mint, is described in *Laboulaye's* "*Dictionnaire des Arts et Manufactures*," i., art. "*Balancier*," Fig. 189 *bis.*

2. An apparatus for controlling the water pressure in the mains and pipes of water-works in the Holly system of water supply.

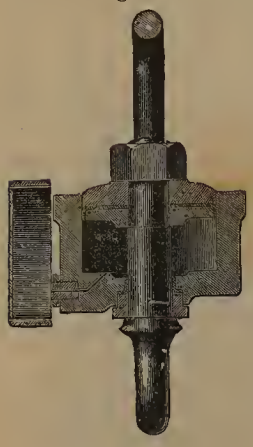
The hydrostatic regulator is provided with a piston, placed within an upright cylinder, and having a rod extending upward which is connected to a cross-bar, having heavy weights, which by means of suitable contrivances bear down upon the piston with a force that increases as the piston rises. A small pipe connects the water mains with the cylinder below the piston, and any change in the water pressure (which would be increased or diminished by opening or closing service-cocks) at once communicates motion to the piston, and the force below the piston is always met by an equal resisting force from the increasing weight. By means of simple appliances, the changes in the position of the piston are utilized to operate on the steam-valves of the engine (or the gates of a water-wheel, if works are run by water-power), and change the point at which steam is cut off in the cylinders of the engine, thereby increasing or decreasing the power of the engines, the speed of the pumps, and the quantity of water supplied. Thus it will be seen that if the piston moves either higher or lower in the cylinder than the point at which it may have been set to maintain the desired pressure, it will automatically bring the speed of the engine to the rate required to supply the demands for water, and permit the pressure to vary only within the limits needed — two or three pounds — to reverse the action of the cut-off moving mechanism of the regulator.

"*Scientific American Supplement*" . . . . 2220.

Hy′dro-stat′ic Weigh′ing Ma-chine′. An apparatus for ascertaining the weight of an object *in transitu*, during the operation of hoisting. Figs. 1423–1425.

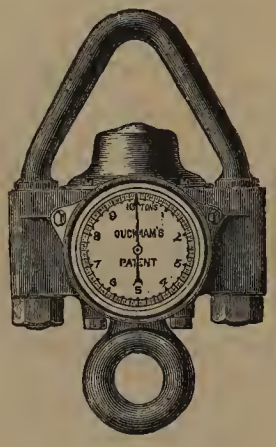
The upper loop is placed over the hook of the crane chain, and the object slung to the ring beneath. To the upper loop is attached the cylinder,

Fig. 1423.



Hydrostatic Weighing Machine. (Section through Suspending Strap.)

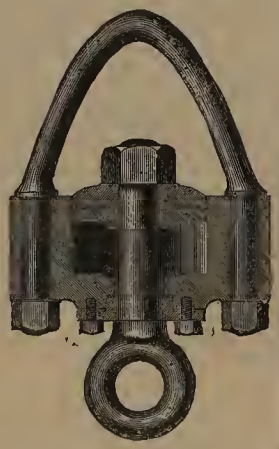
Fig. 1424.



Hydrostatic Weighing Machine. (Front View.)

and to the ring the piston moving in the cylinder and tightly packed therein. The space in the cylinder is filled with castor-oil. When a weight is suspended from the ring, the piston presses on the oil, which passes by a channel to the gage which indicates the weight, in tons and pounds.

Fig. 1425.



Hydrostatitic Weighing Machine. (Section through Gage Connection.)

Hy′dro-the-ra-peu′tic Ap′pa-ra′tus. A shower-bath. In the form invented by Bozerain, of Paris, it is a compact folding arrangement. It may all be contained in a pan with a lid, and when erected for use, has a stem fastened to the slatted floor, and holding a reservoir and a perforated ring for discharging upon the shoulders, the water being raised from the pan by a hand-pump.

* "*Scientific American*" . . . . . xliii. 148.

Hy′dro-ther′mal Mo′tor. An engine invented by Tomassi, in which the dilatation and condensation of oil, caused by the action of heat, transmits motion to mechanism which actuates a piston at the rate of 100 strokes per minute. The chief proposed application of this motor is in the utilization of the heat of the exhaust of steam engines, something after the manner proposed for the bisulphide of carbon and ammonia machines. — "*Les Mondes*," "*Scientific American*," xxxiv. 89.

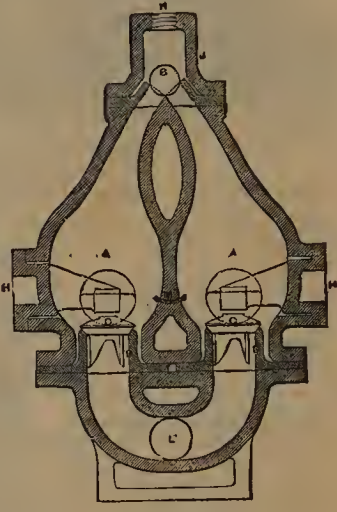
Hy′dro-tri-met′ric Pu′ri-fier. A name given by M. Le Tellier to his apparatus for removing the hardness from water by throwing down the lime, which is afterwards intercepted by filtration through charcoal.

A jet of lime-water is made to mingle with the stream from the supply-pipe, and the precipitated lime is afterwards arrested by filtration. See "*Proceedings of Soc. of Engineers*" (Br.), March 4, 1878, in a paper by J. W. Pearse, reported in "*Van Nostrand's Eng. Mag.*," xviii., p. 472.

See also Feed-water Heater and Purifier, Figs. 1006–1011, pp. 328, 329, *supra;* also Lime Catcher, *infra.*

Hy′dro-tro′phe. The English name of an apparatus for raising water by means of condensing steam in chambers, similar in principle to the *pulsometer*, *aquometer*, etc.

Fig. 1426.



Hydrotrophe.

Steam is admitted to the chambers alternately. The condensation of steam causes the chamber to fill from a source below. Steam admitted above the water forces it to any reasonable height; so on alternately of the chambers.

A revival of the so-called steam-engine of Captain Savary. Fig. 5657, p. 2337, "*Mech. Dict.*"

Hodgkin, Neuhaus, & Co. . * "*Engineering*," xxiv 27, 33.

Hy-grom′e-ter. A measurer of moisture. See instances and descriptions, Fig. 2628, p. 1159, "*Mech. Dict.*"

	"*Scientific Amer.*," xxxviii. 227.
	* "*Scientific American Sup.*," 212.
Hachenberg . .	* "*Scientific Amer.*," xxxvi. 35.
Hair, *Koppe*, Zurich	"*Scientific American Sup.*," 1974.
Hervé Mangon . . .	*Laboulaye*, i., Fig. 5, cap. "*Agriculteur.*"
	Laboulaye, ii.. "*Hygrometre.*"
Simple	* "*Scientific American Sup.*," 2469.
Wagner	* "*Scientific American Sup.*," 808.
Hygroscope, natural	* "*Scientific American*," xxxvi. 67.

Hy′gro-scope. (*Gunpowder.*) An air-tight box in which powder is confined, subjected to a damp atmosphere at uniform temperature for 12 hours, in order to test its capacity for absorbing moisture.

See "*Ordnance Report*," 1879, Appendix I., Plate X. *b*, and description, p. 116.

I.

Ice. Refer to: —

Ice boat, possible veloeity	"*Van Nostrand's Mag.*," xxi. 514.
Tower	"*Scientific American*," xli. 288.
St. Lawrence . . .	"*Iron Age*," xviii., Nov. 16, p. 15.
"Whiff"	* "*Sc. American Sup.*," 996, 1107.
"Icicle"	* "*Sc. American Sup.*," 967; * 12.
	"*Scientific American*," xxxvi. 152.
Ice blasting	"*Scientific American Sup.*," 917.
Ice breaker, *Creasey* .	* "*Scientific American*," xli. 58.
	* "*Iron Age*," xxv., April 1. p. 13.
Ice-cream beater, *Wise* .	* "*Scientific Amer.*," xxxviii. 102.
Ice-cream freezer, *Dexter*	* "*Scientific American*," xxxvi. 6.
Ice creeper, *Austin* . .	* "*Scientific American*," xl. 113.
Ice house, cheap . . .	* "*Sc. Amer. Sup.*," 1570; * 1851.
Ice house and cold room	* "*Scientific American Sup.*," 939.
Ice plow, railway.	
Augamar	* "*Scientific American*," xliii. 387.
Ice tongs, *Euler* . . .	* "*Scientific American*," xxxvii. 38

See also Ice Machines.

Ice Bag. (*Surgical.*) A means for cold application specially made for the spine, the eye, etc. Ice broken in pieces is put into a caoutchouc bag of the proper size and shape.

Head-dress, ice water	"*Scientific American*," xxxv. 342.
Ice hat, medical . . .	"*Scientific American*," xxxix. 345.

Ice Bal'ance. A spring balance registering to 200 or to 400 pounds, by 5's.

Ice Cap. An ice bag for the head. See Ice Bag.

Ice Car. (*Railway.*) 1. One with double sides, floor, ends, and roof; the interstices filled with sawdust or other non-conductor to prevent the ice from melting.

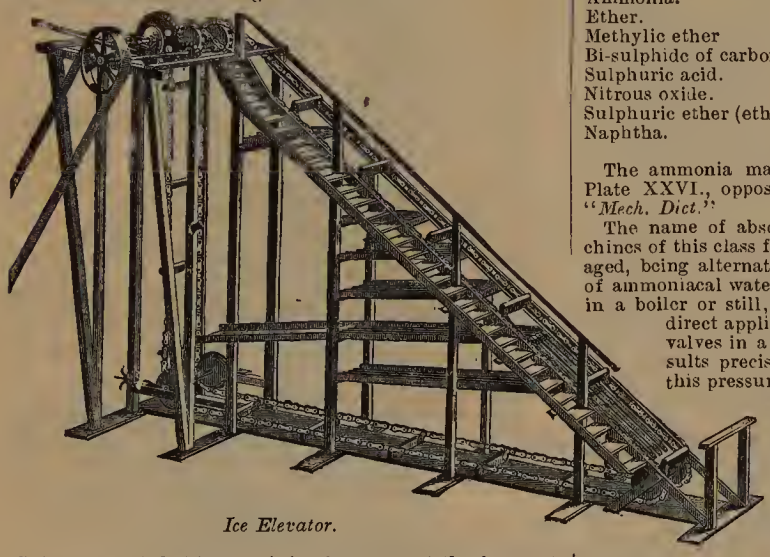
2. See also Ice Locomotive, Fig. 2624, p. 1163, "*Mech. Dict.*"

Ice Chop'per. (*Fishing.*) A tool used in chopping ice for packing fish or bait.

Ice Hook. See Ice Tongs, *g*, *j*, *k*, Fig. 2658, p. 1171, "*Mech. Dict.*"

Ice El'e-va-tor. Fig. 1427 is an inclined plane for endless chain elevator.

Fig. 1427.



Ice Elevator.

It is so placed that its foot is in the water of the ice-pond and its several chutes connect with the stories of the ice-house, or successive elevations of the ice stored therein. An endless chain provided with slats runs over pulleys at the angles of the triangular frame; the foot, vertex, and at the angle of the right-angled triangle. The inclined planes consist of a series of gratings, filling its various panels, and the block of ice caught by one of the slats on the continuously moving chain, slips up the grating as far as the latter extends, which may be to any required distance according to the elevation acquired by the stored ice at any given time. On attaining this elevation, which, in the illustration, has been assumed to be at the second chute, say 20′ from the base, the grating having been removed, the block, no longer supported on its slippery track, passes between the inclined beams on to the chute, which, being inclined, conducts it to the ice-house.

Another form of inclined plane ice elevator is shown in Fig. 2641, p. 1163, "*Mech. Dict.*" See also Ice Screw, *infra*. See also Ice Elevator Chain, Figs. 956, 957, p. 309, *supra*.

Ice Ma-chine'. All artificial refrigeration proceeds upon the general principle of compressing a gas, removing from it when in this compressed state the heat generated by compression, by means of running water, and then permitting the reëxpansion of the compressed gas in a series of pipes or chambers so disposed as to abstract heat from the water to be frozen.

Three cubic feet of atmospheric air at the normal pressure of 15 lbs. per square inch and a temperature of 75° F., being compressed into an iron vessel containing one cubic foot, will show a temperature say of 225° F. Being cooled as above, until its temperature is 75°, and then permitted to expand, the result will be say 3 cubic feet of air at 25°.

Various gases are substituted for air as being more powerful refrigerating agents.

Such gases as can be liquefied by pressure possess manifest advantages for this purpose. Perhaps the most convenient agent known is ammonia.

Machines may conveniently be divided into two classes: —

Absorption machines; in which gas (ammonia) is set free from its watery solution by heat, is condensed, refrigerated, worked, and then reäbsorbed by the water.

Compression machines; in which the gasses are forced to make the circuit by means of pumps.

The absorption machines are those of

Tellier	*Boyle.*	*Stanly-Reece.*
Carré.	*Reece.*	*Mignon & Rouart.*
Rankin.	*Krupp.*	*Kropff.*

The following materials have been used in compression machines for the manufacture of ice. —

Ammonia.	Anhydrous sulphuric oxide.
Ether.	Chymogene (petroleum ether).
Methylic ether	Atmospheric air.
Bi-sulphide of carbon.	Gasoline.
Sulphuric acid.	Carbonic acid.
Nitrous oxide.	Alcohol.
Sulphuric ether (ethylic).	Ethylo-sulphurous dioxide.
Naphtha.	Rhigoline.

The ammonia machine of Ferdinand Carré is shown in Plate XXVI., opposite p. 1164, and described on p. 1165, "*Mech. Dict.*"

The name of absorption machine has been given to machines of this class from the manner in which the gas is managed, being alternately distilled and reabsorbed. A charge of ammoniacal water or aqua-ammonia having been placed in a boiler or still, the gas is driven from the water by the direct application of heat; the gas being retained by valves in a receiver or series of pipes, pressure results precisely as in a steam boiler. While under this pressure, running water passes around the receiver or pipes, and the temperature of the gas is sufficiently reduced, so that it liquefies under the pressure which is derived directly from the still. This liquefied gas, after expanding in a chamber or in a series of pipes, for the purpose of reproducing refrigeration by absorbing heat from substances surrounding the pipes, is then reabsorbed by the water which originally held it in solution.

In these machines mechanical force is dispensed with, excepting in the slight power required to pump the water back into the still pipes, after it has reabsorbed the ammoniacal gas.

Plate XXIII shows a small Carré ice machine of domestic size in which an ammonia solution serves indefinitely. It requires for operation nothing but fire and water, and, as soon as one block of ice is congealed it is ready to commence another It is specially intended for ices, caraffes, sorbets, etc., but has its uses also in the laboratory.

In the Rankin Ice Machine, shown in Plate XXIII., the distillation of ammonia is effected by passing the aqua-ammonia through a series of 6″ or 8″ pipes, and finally taking the weak water from the lowest pipe, that is, the last one of the series of small still pipes. The number of these pipes varies from 3 to 18, according to the capacity of the machine. The ammonia passes from each still pipe at the rear end at the same time that the water passes from the front end to the next pipe below. A small pump forces the exhausted water back from the absorber into the still pipes. The absorbers are made of 3″ or 4″ pipe, jacketed for the cooling water to pass the reverse way of the heat. The same arrangement is applied in the construction of the condensers, equalizers, and cooling coils, so that the hottest meets the hottest and the cooler the cooler, in all the interchanges of the machine. Steam-pipes inserted in the still pipes is the preferable mode of heating.

In the Rankin machine the parts are numbered as follows: —

1. Still front.
2. Boiler.
3. Water pump.
4. Ammonia pump.
5. Still pipes
6. Weak water receiver.
7. Stand pipe.
8. Equalizer.
9. Gas receiver.
10. Strong water receiver.
11. Pipe from absorber to strong water receiver.
12. Gas expansion pipes.
13. Pipe to cooling coil.
14, 15. Pressure gages.

16. Header.
17. Pump suetion.
18. Gas eonductor to eondenser.
19. Gas conductor from condenser to gas receiver.

The apparatus of Mignon & Rouart, Paris, is also on the Carré principle.

Pictet reduees temperature by expausion of anhydrous sulphurous oxide. The liquid, eontained in a refrigerator, is vaporized under the ordinary atmospheric pressure hy a double-aeting pump, furnished with couductiug pipes, and whieh compresses it under a maximum of three atmospheres after eireulation into a condenser, where it is liquefied anew to be brought haek to the refrigerator. The heat produeed by liquefaetion is absorhed in the eondeuser. The circulation of a solution of magnesium ehloride, between and around iee-molds, is effeeted by the motion of a helix, whieh revolves eonstantly in the bath. The heat of the tropies and that of the aretic regions are found coutiguous to eaeh other in the conducting pipes of the pump.

The maehine of M. Pietet, shown iu perspective and seetion in Plate XXIII., uses anhydrous sulphurous acid. In the use of this, there is the advantage that at 80° Fah. its tension does not exceed four atmospheres, while it may he liquefied at 25°, aud its tension then is only equal to the pressure ot the atmosphere. It has no action upon metals when kept free from water; and in order to obtain it in a perfectly anhydrous condition, M. Pietet prepares it by the action of heat on a mixture of oil of vitriol and sulphur, the gas beiug dried by oil of vitriol. The condensing and refrigerating apparatus eonsists of tubular vessels similar to those employed with other liquids, such as ether.

A machine capahle of produeing 550 pounds of ice per hour is thus described: —

"A eyliudrical tuhular copper boiler has a length of 2 meters and a diameter of 35 eentimeters; 150 tubes of 15 millimeters traverse its entire length, and are soldered by their extremities to the two ends. This first hoiler is the refrigerator. It is placed horizontally in a large sheet-iron vat, which eontains 100 tanks of 20 liters each. An incongealahle liquid, salted water, is constantly circulating in the interior of the refrigerator by means of a helix. This liquid is re-eooled to about — 7° C. in a normal course, and it licks on its return the sides of the tanks whieh eontain the water to be frozen.

"In the space reserved between the tubes of the refrigerator, the sulphurous acid liquid is volatilized, and its vapors are drawn up hy an aspirating force-pump, which compresses them without the condenser. This condenser is a tubular boiler, the same as the refrigerator: only a current of ordinary water passes constantly into the interior of the tubes to carry off the heat produeed hy the ehange of the gaseous into the liquid state of the sulphurous acid, and by the work of compression. A tube furnished with a gage-tap, adjusted by the hand once for all, permits the liquefied sulphurous acid to return into the refrigerator to be subjeeted anew to volatilization.

"Sulphurous acid has the exceptionally advantageous property of being an excellent lubricant, so that the metallic piston which works in the cylinder of the compressing pump requires no greasing. Thus the introduction of foreign matter into the apparatus becomes entirely impossihle.

"The work nccessary to manufaeture 250 kilograms of ice per hour is at the most seven horse power. A cold of 7° C. in the hath is amply sufficient to obtain in the tanks a rapid and in every way economical congelation. The cost of production is about 10 francs per ton of ice." — "*Nature*."

The perspective view represents a machine on a small scale. A larger apparatus is shown in "*Scientific American*," * xxxvii. 336.

Beneath is a diagrammatic view of the Pictet machine. At *A* is the eompression pump, the valves of which are so arranged that at one stroke the gaseous oxide is aspirated through the tube *B*, and on the return it is compressed through the tube *C*. Tube *B* eonnects with the refrigerator *D*; tube *C* with the condenser *E*. The oxide is iutroduced at the plug lock *F*, and is drawn by the pump in the direction of the arrow into the copper tubular refrigerator *D*, the liquid filling the spaee between the tubes. Here vaporization and consequent production of intense cold takes place, and the temperature of the nou-congealable mixture of glycerine and water which surrounds the refrigerator is so far reduced that water placed in the metal boxes *H*, immersed in the tank, bccomes rapidly frozen. The propeller wheel, shown on the right, determines a current of the glycerine solution through the tubes, and thus hastens the refrigeration. The vapor of the oxide is drawn out of the refrigerator, as already noted, by the pump, carried through the latter, and forced into the space between the tubes of the condenser *E*. Through the tubes a cold stream of water is constantly pumped, which determines the condensation of the vapors, and the reliqueficd oxide passes into the admission pipe and onee more enters iuto eirculatiou as already described.

Mignon & Rouart, Paris, use in the domestic machine the solution of ammonia, requiring but the addition of water and heat, alternately. In their larger machine a pump is added.

Sulzer Frères (*Linde*), Winterthur, Switz., operate by the evaporation and reeondensation of ammonia, produeed by the aetion of a double-aeting suction aud foree pump.

Siddeley & Co. (Br.) use sulphuric ether. This ether is vaporized in a partial vacuum, and absorbing heat from hrine during its vaporization, the vapor thus produced is subsequently eondeused and liquefied, to be again vaporized, and so on. The water-vessels are exposed in the hrine hath. The excess of heat in recondensation of the ether is carried off by contaet of surface exposed to a flow of water.

Harrison, in his original apparatus, used ether.
Prof. Twining used sulphuric ether.
Liebe (Br.) used sulphuric ether.
Tellier, methylie ether.
Prof. Paersh, chymogene (petroleum ether) and earbon bi-sulphide.
Prof. Vander Weyde, ehymogene.
Prof. Lowe, carhonic acid.
Prof. Seely, liquefied sulphurous aeid.
du Motay & Rossi employ ethylo-sulphurous dioxide obtained from ordinary ether by saturating the latter with sulphurous gas.
du Motay & Beckwith, ethylo-sulphurous dioxide.
Boyle, amuonia.
Atlas Engine Co. (Br.), ether.
Duvallon & Lloyd, ether.
Holden, ether, methylic ether, ehymogene, etc. (optional.)
Linde (*Sulzer Frères*), ammonia.
Kropff, ammonia.
Edmond Carré, sulphuric acid.
Johnston & Whitelaw, ammonia.
Kirk, air eondensed and then expanded.
Winhausen, air eondensed and then expanded.
Gorrie, air condensed and then expanded.
Vincent, methyl-chloride.

Toselli's machine for domestic uses, uses suh-carbonate of sodium or nitrate of ammonium, with an equal weight of water, in the interstices between tubes in a nest.

Glaeière *Delpy* employs hydro-ehlorie aeid and sulphate of soda.

Mansfield uses a deliqueseent salt.

The principles involved in the various orders of proeedure: vaporization, radiation, liquefaction, and reduction of pressure, have been considered on pp. 1164-1169, "*Mech. Dict.*"

See machines iu . .	"*Chem. News*," Jan. to Sept., 1876.
	"*Sc. American Sup.*," 1348, * 1440.
	"*Scientific American*," xliii. 277.
Ammonia	"*Scientific American*," xl. 405.
Atlas Engine Co., Br.	* "*Engineering*," xxviii. 13.
	"*Technologiste*," xli. 714.
Boyle	* "*Scientific American*," xlii. 246.
Carré, Edmond . .	* "*Mech. Dict.*," p. 1164, Plate XXVI.
Carré, Ferdinand .	* "*Mech. Dict.*," p. 1164, Plate XXVI.
	* *Laboulaye's* "*Dict.*," iv., ed. 1877.
	Cap. "*Production du froid*," Figs. 3707, 3708 *bis*.
du Motay & Beckwith	* "*Scientific American*," xlii. 118.
du Motay & Rossi .	* "*Engineer*," l. 144.
	* "*Scientific American Sup.*," 3794.
	"*Scientific American*," xliii 277.
Duvallon & Lloyd, Br.	* "*Scientific American*," xxxviii. 387.
Gesner	* "*Mining & Sc. Press*," xxxvi. 65.
Gorrie	* "*Mech. Dict.*," p. 1169.
Harrison	"*Mech. Dict.*," p. 1166.
Holden	* "*Scientific American*," xxxvii. 95; xxxviii. 159, 162; xl. 166; xlii. 322.
	* "*Manufacturer & Builder*," ix. 198.
Johnston & Whitelaw	"*Mech. Dict.*," p 1167.
Kirk	"*Mech. Dict.*," p. 1168.
Kropff	* "*Manufacturer & Builder*," xii. 201.
Paper by Ledoux.	
"*Annales des Mines*"	* "*Van Nostr. Mag.*," xxi. 89, 177, 314.
Linde, Ger.	* "*Scientific American Sup.*," 2713.
	* "*Engineer*," l. 211.
Lowe	"*Mech. Dict.*," p. 1169.
Lugo & McPherson .	"*Mech. Dict.*," p. 1169.
Manchester (Br.) Ice Co.	See *Siddeley & Mackay*.
Portable, *Mansfield* .	* "*Mining & Sc. Press*," xxxvii. 184.
Pictet	* "*Scientific American Sup.*," 425.
	* "*Sc. Am.*," xxxvii. 335; xxxiv. 403.
	* "*Manuf. & Builder*," x. 100.
	* "*Mining & Sc. Press*," xxxvi. 321.
Reece	"*Mech. Dict.*," p. 1167.
Seely	"*Mech. Dict.*," p. 1167.
Siebe	"*Mech. Dict.*," p. 1167.
Siddeley & Mackay, Br.	* "*Engineering*," xxiii. 481.
	"*Iron Age*," xxii., Sept. 19, p. 24.
	* "*Sc. American Sup.*," 1159, * 1439.
Skating Rink, London	"*Scientific American Sup.*," 550.
Tellier	"*Mech Dict.*," p. 1167.
Toselli	* "*Scientific American Sup.*," 507.
Twining	"*Mech. Dict.*," p. 1167.

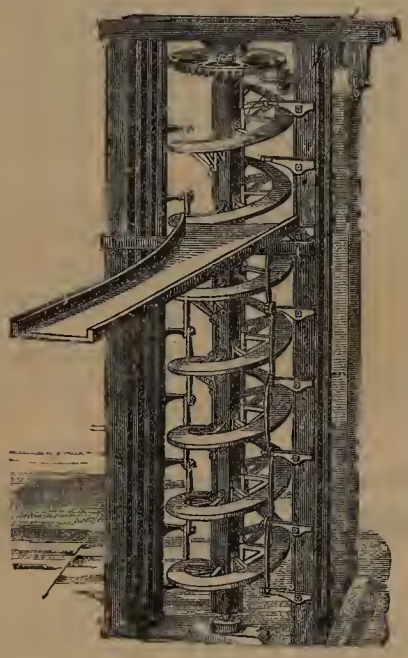
Tuttle & Lugo . . . "*Mech. Dict.*," p. 1169.
Van der Weyde . . . "*Sc. American*," xxxiv. 177, 228.
"*Mech. Dict.*," p. 1167.
Methylehl. *Vincent*, Fr. * "*Scientific American*," xli. 123.
West . . . . . * "*Mining & Sc. Press*," xxxvii. 337.
Windhausen . . . . * "*Mech. Dict.*," p. 1168, Fig 2406.

See *LeDoux's* "*Ice-making Machines.*" (From the French.)

Ice Mold. A metallic case in which cream or custard is frozen so as to acquire a certain shape, which it retains for a while when deposited upon a dish.

Ice Screw. A machine for elevating ice from the pond to the ice-house, or from one level

Fig. 1428.



Ice Screw.

to another. The block of ice rests against vertical bars, and, as the screw revolves, is pushed up, rising vertically till it reaches the level where it is wanted. Here the block is no longer detained by the vertical bars, and slips off on to the chute which has been disposed to receive it and conduct it to the window of the ice-house.

Ich'thy-o-col'la. The preferable name for isinglass.

Classification by *Danilewski* in "*Technologiste*," xli. 515.

LIST OF UNITED STATES PATENTS.

Jan., 1834, *Norwood et al.*, Sounds are cut, digested, run into strips and dried.
2,474 *Paulsen*, Boiling under pressure.
5,978 *Rowe*, Rollers cooled by circulation of water.
29,596 *Hunter*, Glue from whale-blubber scraps.
40,933 *Herreshoff*, Mer-laden fish-water as a dye.
53,636 *Lewis et al.*, Purifying the materials by boiling.
59,331 *Steart*, A "pure" bath of digested fish in treating fiber.
78,016 *Robinson*, Gelatine from fish-heads.
106,212 *Rowe*, Cooling rollers in isinglass manufacture.
134.690 *Manning*, Cooling rollers in isinglass manufacture.
148,317 *Müller*, Sturgeon sounds; solution saltpeter followed by sulphur fumes.
149,165 *Stanwood*, Alcohol and isinglass.
167,123 *Rogers*, Fish-skins scaled, de-salted, digested.
177,764 *Stanwood*, Fish-skins soaked, dried, digested, dried.
219,667 *Alsing*, Albumen from fish spawn.

Il-lu'mi-na'ted Sign. The number-signs of houses in Paris are in numerous cases illuminated by the following contrivance: —

"It consists of a hollow triangular prism 9″ long, two of whose sides are formed of panes of blue glass, on which the number of the house is picked out in white. This prism-shaped lamp-glass rests against the front of the house, so that the two sides with the numbers on them can be plainly seen by the passers-by. In the interior of the prism is a gas jet, fed by a pipe from the house." — "*Telegraphic Journal.*"

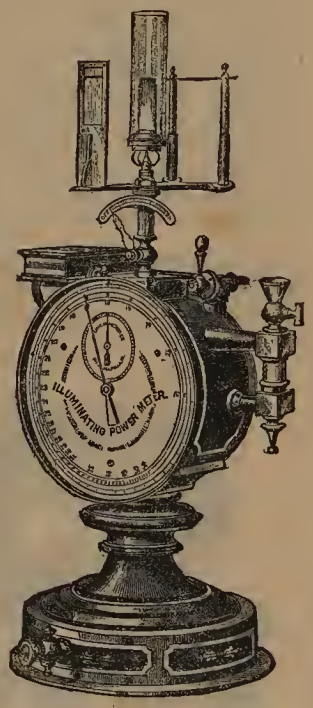
Phosphorescent signs and dials have been used to some extent. See DIAL, p. 254, *supra*, where are several recipes, and numerous references.

See also DIAL, *Morton*, "*Scientific American*," xl. 180, 232.

Il-lu'mi-na'ting Pow'er Me'ter. (*Gas.*) An instrument, by Sugg, of London, designed as a ready means to ascertain the exact illuminating value of gas, in terms of sperm candle values; it can be used in the office or any desired place, as it does not require a darkened room.

After adjusting the height of flame to 3″, the correct reading of any test can be made by an observation of one minute. It occupies a space of about one foot square, and consists of an experimental meter and clock. The dial of the meter is 12″ diameter, its outer circle being divided into spaces of varied lengths, each representing one candle, these spaces being subdivided into tenths of candles. Above the center of dial is a circle having 60 divisions, each representing one second of time, *i. e.*, one minute the whole revolution. A long hand traverses the outer circle and a shorter one the small one. On the side of the meter is a water-box with glass, showing true water-line, and on the top is a governor, three-way cock, pedestal, a quadrant with 45 equal divisions, an argand burner with chimney, and a sighting frame to enable the operator to adjust the flame to exactly 3″. To operate the instrument, start the clock, then adjust the height of flame to 3″, when the gas is passing through the meter, stop the hand at 16 by turning the cock so that the gas passes to the burner without going through the meter, then wait till the clock-hand moves to 60, at this instant turn the gas through the meter and let it pass through till the clock-hand again reaches 60, at this instant turn off the gas from the meter, and the long hand (or pointer) will indicate the quality of gas.

Fig. 1429.



Illuminating Power Meter.

Il-lu'mi-na'ting Tile. One with glass bull's eyes for sidewalks over cellars and areas, or pavement over basements.

Il-lu'mi-na'tion.

The following is a London test of the illuminating value of the materials named: —

Material.	Value. 24 cents equal 1 shilling.	Duration of 1 cent's worth in one sperm candle values.
		h. m.
Standard sperm candles, per lb. .	$0.48	1 7
Best wax candle, per lb.	.48	1 6
Sperm oil in moderator, per gal. .	2.28	1 12
Belmont sperm candle, per lb. . .	.30	1 27
Stella or Burmese wax, per lb. . .	.30	1 37
Petroline candle, per lb.	.36	2 15
Composite candle, No. 1, per lb. .	.22	2 5
Composite candle, No. 3, per lb. .	.16	2 45
Common dip candles, per lb. . .	.12	2 52
Almond oil, in moderator, per gal.	2.22	3 –
Colza, per gal.	1.20	4 37
Paraffine oil, in lamp, per gal. . .	.72	9 35
Common London gas, per 1,000′ .	.90	26 –

It may be noted that the price of gas, 90 cents per 1,000′ is scarcely more than one third of the exorbitant prices usual in the United States.

Il-lu′mi-na′tor. 1. (*Surgical.*) *a.* A lamp with lens used as a means of directing a strong light, in examination by the laryngoscope, ophthalmoscope, speculum, etc. Pages 78, 79, Part II., and Fig. 545, Part III., *Tiemann's "Armamentarium Chirurgicum."*

b. An instrument for illuminating an internal cavity by means of incandescent platinum in a glass envelope.

3. A glazed opening; such as floor-light, deck-light, side-light, bull's-eye, etc., which see.

4. (*Microscope.*) A special attachment for throwing light upon an object under view. See list under ILLUMINATOR, * 2660, p. 1171, *"Mech. Dict."*

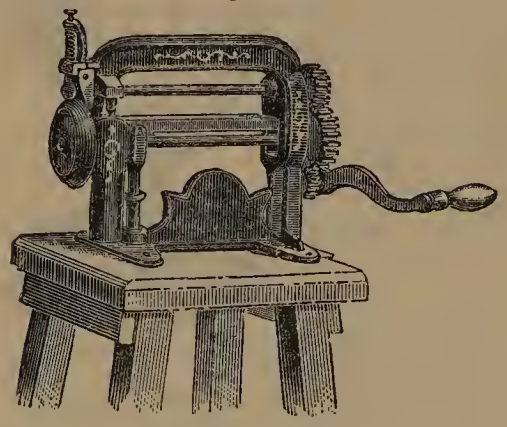
Im-pe′ri-al Silk Serge. (*Fabric.*) A silk and wool French goods.

Im′preg-na′tion. (*Mining.*) Metallic deposits having undefined limits and form.

Im-pres′sion Ma-chine′. (*Cartridge.*) A machine for making an impression in the head of the cup, which is done by a horizontal die pressing it into a pattern, so that, when vented, the holes will not be on the top but on the side of the impression.

Im-pres′sion Stitch Ma-chine′. (*Leather.*) A machine for crimping the upper edge of welts of a boot or shoe to give it the appearance of sewed work.

Fig. 1430.



Impression Stitch Machine.

The machine shown in Fig. 1430 makes a stitch impression of any desired width or size.

Im-pres′sion Tray. A tray of Britannia metal to hold the gypsum in taking impressions of the mouth for the making of dentures.

Fig. 1431.

Impression Tray.

They are made of various sizes, and specifically for upper and lower jaws. They are light enough to allow of alteration by pliers or mallet to suit peculiar formations of the maxillary.

Incan-des′cent Light. (*Electricity.*) A form of electric light as distinct from the *voltaic-arc* light. In the *incandescent* light a strip of carbon or platinum is heated to whiteness, *in vacuo*, or in a rarefied atmosphere of an inert gas, nitrogen, for instance.

In the voltaic arc light, the current leaps the space between two pencils of carbon.

"The incandescent systems are far less numerous than those which employ the voltaic arc, and hence their classification is less complex. They are divided into

"1. Incandescent lamps with combustion.

"2. Lamps purely incandescent.

"The former are represented by Reynier's, Weidermann's (Napolio's modification), Joel's, and Tommasi's apparatus. All of these consist of a carbon rod resting lightly on a lump of carbon or an irregularly-shaped piece of metal, thus producing imperfect contact.

"Pure incandescence is represented in four systems: those of Edison, Maxim, Swan, and Lane-Fox. In all of these we have incandescence of carbon, and this carbon consists of a very fine thread placed *in vacuo* or in a highly rarefied atmosphere of some inert gas.

"The nature of the current is a matter of indifference with incandescent lamps; they work with either continuous or with alternating currents. Those lamps in which there is incandescence with combustion require a great *volume* of current, and rise in *tension*, while those with pure incandescence require small *volume*, and usually rise in *quantity*.

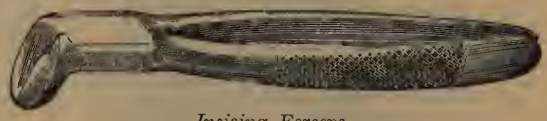
"To pure incandescence we must also refer Jablochkoff's, Kavlin's, Trouvé's platinum wire polyscopes and Geissler's tubes; but properly speaking these are not electric-light apparatus at all, but only objects to be used for study or for experiment." — *"Electrician."*

Inch. The "miner's *inch*" is the amount of water that will flow in 24 hours through a hole 1″ square with 6″ pressure — about 2,000 cubic feet.

In effective hydraulic mining there should be at least 1,500 inches, each one of which will move from 3 to 5 cubic yards of gravel per day. See statement by Mr. Thomas, reported in *"Scientific American,"* xl. 314.

In-ci′sing For′ceps. (*Dental.*) An instrument for separating, cutting between teeth, splitting and excising salient prongs or parts.

Fig. 1432.



Incising Forceps.

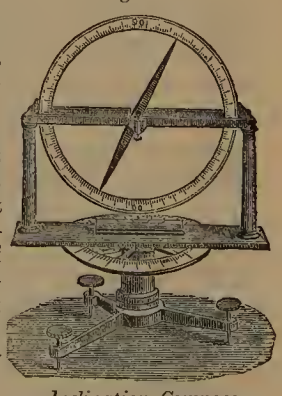
In-ci′sor For′ceps. (*Dental.*) An instrument with narrow single prongs for extraction of the incisors.

Fig. 1433.

Incisor Forceps.

In′cli-na′tion Com′pass. A magnetic needle with vertical circle to indicate the *inclination* or *dip*, one of the three elements of magnetic force registered at the observatories. The invention of *Norman*, of London.

Fig. 1434.



Inclination Compass.

See DIPPING NEEDLE, Fig. 1659, p. 705, *"Mech. Dict."* The illustration, Fig. 1434, shows the instrument with a leveling stand and horizontal circle with magnetic needle.

In-clined′ Plane. An artificial slope for ascent of vehicles or objects; the term in its most important signification concerns railway grades. Many of them, traversed by locomotives, are very bold; some are only surmounted by means of stationary engines and cables.

The subject is treated on pp. 1174-1177, *"Mech. Dict.,"* references being made to the inclined planes of

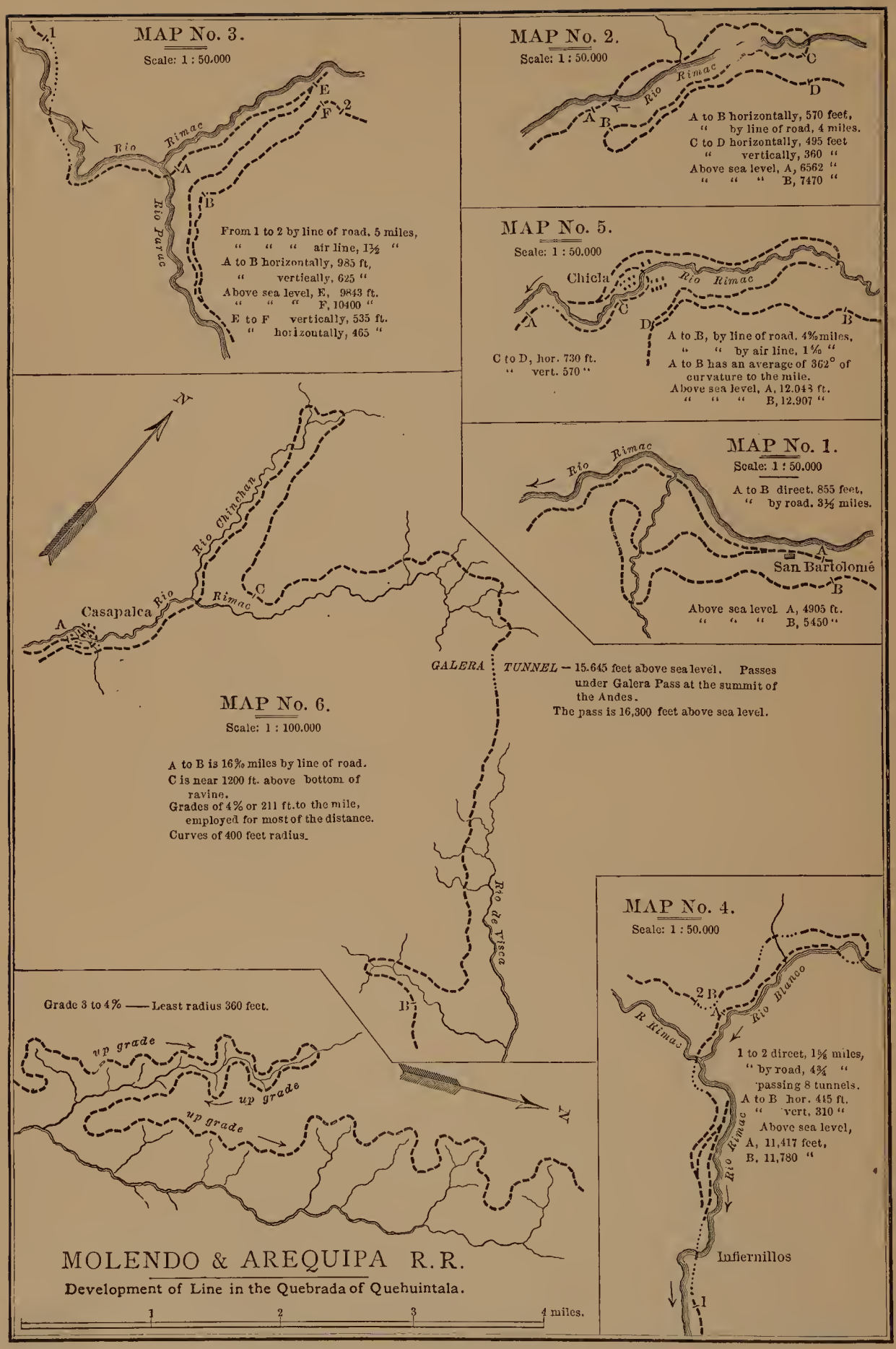

MAP No. 3.
Scale: 1 : 50.000
Rio Rimac
Rio Purus
From 1 to 2 by line of road, 5 miles,
" " " air line, 1½ "
A to B horizontally, 985 ft,
" vertically, 625 "
Above sea level, E, 9843 ft.
" " " F, 10400 "
E to F vertically, 535 ft.
" horizontally, 465 "
MAP No. 2.
Scale: 1 : 50.000
Rio Rimac
A to B horizontally, 570 feet,
" by line of road, 4 miles.
C to D horizontally, 495 feet
" vertically, 360 "
Above sea level, A, 6562 "
" " " B, 7470 "
MAP No. 5.
Scale: 1 : 50.000
Chicla
Rio Rimac
A to B, by line of road, 4⅝ miles,
" " by air line, 1⅝ "
A to B has an average of 362° of curvature to the mile.
Above sea level, A, 12.043 ft.
" " " B, 12.907 "
C to D, hor. 730 ft.
" vert. 570 "
MAP No. 1.
Scale: 1 : 50.000
Rio Rimac
A to B direct, 855 feet,
" by road, 3½ miles.
San Bartolomé
Above sea level A, 4905 ft.
" " " B, 5450 "
Rio Chipchan
Casapalca
Rio Rimac
GALERA TUNNEL — 15.645 feet above sea level. Passes under Galera Pass at the summit of the Andes.
The pass is 16,300 feet above sea level.
MAP No. 6.
Scale: 1 : 100.000
A to B is 16⅜ miles by line of road.
C is near 1200 ft. above bottom of ravine.
Grades of 4% or 211 ft. to the mile, employed for most of the distance.
Curves of 400 feet radius.
Rio de Yisca
MAP No. 4.
Scale: 1 : 50.000
Rio Blanco
R. Rimac
1 to 2 direct, 1⅝ miles,
" by road, 4¾ "
passing 8 tunnels.
A to B hor. 415 ft.
" vert. 310 "
Above sea level,
A, 11,417 feet,
B, 11,780 "
Rio Rimac
Infiernillos
Grade 3 to 4% — Least radius 360 feet.
up grade
up grade
up grade
MOLENDO & AREQUIPA R.R.
Development of Line in the Quebrada of Quehuintala.
1
2
3
4 miles.

PLATE XXIV. DEVELOPMENTS OF INCLINED PLANES ON PERUVIAN RAILWAYS. *See page* 491.

Reduced from the Surveys in the Office of Señor Henry Meiggs, Lima.

Mount Cenis.
Holidaysburgh (former) route of Pennsylvania Railway.
Portage, Pennsylvania canal.
Mahanoy, Pennsylvania.
Mount Washington.
Morris and Essex Canal, N. J.
Callao, Lima, and Oroya Railway, South America.
Furka pass, Switz.
Konkan, Bombay
Righi, Switz.

The publication of some engineering data of the Callao, Lima, and Oroya Railway, South America, (Fig. 2664, p. 1175, "*Mech. Dict.*") coming to the notice of Mr. Henry Meiggs, of Lima, Peru, Mr. Jno. McGee of his staff was so obliging as to send careful reductions of the maps of the most interesting developments of the road, which have been reproduced in Plate XXIV. These have all been completed and are numbered in the order the localities are reached in going from the sea.

The descriptions are printed in the panels with each map. In regard to the summit development, No 6, it may be said that a 60-ton engine takes 60 tons, net load, over the road at 12 miles per hour with ease.

Near the beginning of p. 1176, "*Mech. Dict.*," it was stated that "the longest inclined plane on an artificial road is said to be that from Lima to Callao, which is about 6 miles, and has a descent of 511′, or about 1 in 60." It must now be added from information furnished by Mr. McGee that "the Oroya railway has an average incline for 75 miles of about 1 in 30."

The map of a development on the railway from Molendo to Arequipa, Peru, shown also in Plate XXIV., exhibits the approach to the pampa of Islay, which has a general level of 4,000′ to 5,000′ above the level of the sea.

The subject of inclined planes ascending by cogged gear on locomotive is considered incidentally under INCLINED PLANE, "*Mech. Dict.*"; also RACK RAIL, p. 1852, *Ibid.* Righi Railway, * Fig. 4124, p. 1862, *Ibid.*, and various systems cursorily mentioned on p. 1861, *Ibid.*

The following high grades in Switzerland are mentioned in the journals: —

"A road recently opened up Mt. Uetliberg, Switzerland, overlooks, at a height of 1,300′, Lake Zurich. The total length is 5½ miles. The lowest grade is 232′ per mile, but 59 per cent. of the whole exceeding 264′ per mile. The curves are 500′ and 450′ radius, the latter coinciding with a grade of 327′. The track is standard gage, and the rails, of iron, weigh 60 lbs. There are three tank locomotives of the Krauss pattern, with six drivers coupled, each 38″ diameter, and with a wheel base of 6′ 8″. They weigh 41,800 lbs. empty, and in service, from 52.800 to 55,000 lbs. The heating surface is 770′ square, diameter of piston 12½″, stroke 21½″. At the first ascent the engine pushed up three cars with gross load of 30 tons, at from 8 to 10½ miles per hour, with steam pressure of 170 lbs. The descent is made with compressed air, by means of an apparatus used on the engines of the Righi road; speed 15½ to 18½ miles per hour.

"Another Swiss mountain road, the Righi Kulm and Lake of Zug, is 7 miles long; 6 miles are worked with a peculiar cogged wheel arrangement, by which grades of 1,056′ per mile are surmounted; radii of the curves, which are uniform, 600′."

PENNSYLVANIA IRON REGION.

Planes.	Total Length of Planes.	Height of Head above Tide.	Height of Foot above Tide.	Total Elevation.	Length of Main Rope required.	Diameter of Main Rope.	Weight per Foot.
	Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*In.*	*Lbs.*
Mahanoy	2,410	1,478.42	1,124.70	353.72	2,900	2¼	8½
Gordon, 1	4,650	1,519.00	1,200.50	318.50	5,105	2¼	8½
Gordon, 2	4,755	1,206.00	802.00	404.00	5,225	2¼	8½
Big Mine Run. .	1,245	1,274.3	1,013.8	20.65	1,550	2	–

The Mahanoy has steel wire rope 2¼″ diameter with independent steel wire rope center. The others 2¼″ diameter iron wire rope (Big Mine 2″) with independent iron wire rope center.

A new locomotive for use on Ithaca Hill, N. Y., is thus described: —

"The incline has five tracks, of which the outer two are of the usual width, used in the ordinary manner. When the engine starts up the hill it rests upon a pair of rails just within the usual track and upon a set of double-flanged small driving-wheels which are upon the same axles with the big drivers, they being only about 30″ in diameter; this inside track is raised about 15 to 18″ above the outer one, and so high that the big drivers do not touch the track at all; the engine rests now upon the small drivers, and is independent of the outer ones; then in the center of the track is placed a wide cogged rail, which meshes into the cog-wheel, which is between these small drivers, directly under the center of the locomotive. By applying power to the big drivers, in the ordinary way, the power is applied to the cogged-wheel, which does the climbing. The cogs are about 3″ from tip to tip, and the wheel is 8″ wide."

CINCINNATI INCLINED PLANES.

	Mount Auburn.	Price's Incline, Mill Creek.
Vertical height . . .	275 feet.	346 feet.
Length of track . . .	840 feet.	758 feet.
Angle of incline . . .	○	24°.
Wire rope	1⅜″ diameter.	1¼ inch.
Wire rope weight. .	–	39 tons.
Drum	9′ diameter	9 feet.
Actual strain on rope .	–	6 tons.
Number of winds . .	27	
Time in windiug . . .	1 to 1½ minutes.	1′ 12″ to 1′ 15″
Engines	2, double act.	Same.
stroke	24″	
diameter	12″	
Made by John Cooper	Company, Mount	Vernon, Ohio.

The inclined plane of the Jeffersonville, Madison, and Indianapolis Railway at its landing on the Ohio River, has an ascent of 300′ in a mile, or 1 in 17. Wire rope is used.

When a locomotive ascends a grade and then winds up the train to its own level, either of two means may be employed. In each, a rope and winding drum is employed.

1. The winding drum is attached to the engine, which is detached from the train at the foot of the incline, attaches the rope to the forward car, and mounts the incline alone, is anchored to the rails, and then draws the car up after it. It may be anchored part of the way up, draw the cars to itself, the cars be anchored at this point, and then the engine ascend and repeat.

2. The winding drum is at the summit; the engine ascends and so places itself that its driving-wheels are over other wheels of the winding drum. The engine being anchored, its wheels in motion wind the drum, and draw upon the rope.

In each case the train is let *down* the grade by a brake on the drum.

The locomotive of Henry Handiside, of Bristol, Br., is constructed for this purpose. It has a gripping lock which holds the rails, and a drum beneath, operated by another cylinder, for winding the wire cable which connects to the front coach of the train. The locomotive ascends a piece, paying out the cable: then locks itself and hauls up the cars. These are then locked, and the locomotive makes another ascent and repeats. On a level, the locomotive acts in the ordinary manner: shown in Paris, in 1878.

COMPARISON OF DIFFERENT METHODS OF DESIGNATING GRADES.

Engineer	English.	American R. R.
.5 in 100	1 in 200	26.4 feet per mile.
1 in 100	1 in 100	52.8 feet per mile.
1.5 in 100	1 in 66 2-3	79.2 feet per mile.
2 in 100	1 in 50	105.6 feet per mile.
2.5 in 100	1 in 40	132 feet per mile.
3 in 100	1 in 33 1-3	158.4 feet per mile.
3.5 in 100	1 in 28 4-7	184.8 feet per mile.
4 in 100	1 in 25	211.2 feet per mile.
4.5 in 100	1 in 22 2-9	237.6 feet per mile.
5 in 100	1 in 20	264 feet per mile.
5.5 in 100	1 in 18 2-11	290.4 feet per mile.
6 in 100	1 in 16 2-3	316.8 feet per mile.
6.5 in 100	1 in 15 5-13	343.2 feet per mile.
7 in 100	1 in 14 2-7	369.6 feet per mile.

Refer to: — Bessemer Ill. . * "*Engineering*," xxi. 462.
Bhor, India . . . . . 'Sc. American Sup.," 919.
Callao, Lima & Oroya Ry. . * "*Engineering*," xxviii. 46, 104.
Cincinnati . . . . . "*Sc. American Sup.*," 1905.
Tramway, fortress of Glatz, Silesia. . . . . * "*Engineer*," xliv. 462.

Grand Combe mines, Fr.	* "*Engineering*," xxvii. 36.
Hyd. hauling machine for Hayward, Tyler & Co.	* "*Engineering*," xxiii. 362.
Pittsburg Passenger Ry.	* "*Scientific Am.*," xliii. 175.
Winding engine, Gordon	* "*Engineer*," xliii. 77.
Safety trucks, Mahanoy	* "*Engineer*," xliii. 78.
Woottens, patent	No. 57,423, Aug. 21, 1866.

Table showing the proportions between an engine's maximum load on grades up to 350 feet per mile, and its maximum load on level, the latter being 100 per cent.

Grades.	Per cent.	Grades.	Per cent.
0	100	130	11.6
5	82.8	140	10.6
10	68.1	150	9.8
20	50	160	9.2
30	39.3	170	8.6
40	32.3	180	8
50	27.3	190	7.5
60	23.5	200	7.1
70	20.7	225	6.1
80	18.3	250	5.3
90	16.4	275	4.7
100	14.9	300	4.2
110	13.6	350	3.3
120	12.4		

In-clined' Plane Car. (*Railway.*) One for ascending inclined planes; the support of the bed being so arranged that the bed shall be level when the car is on the incline. The Righi, Mt. Washington, and others afford examples. See INCLINED PLANE, "*Mech. Dict.*," *et supra.* RAILWAY, "*Mech. Dict.*," pp. 1061, 1062, and references *passim.*

In-clined' Press. One of which the bed and die are inclined, for convenience of insertion of the blanks. Cutting, drawing, and stamping presses are sometimes thus built, and sometimes are adjustable so as to have either level or inclined table.

In-cline' Drift. (*Mining.*) An inclined passage under ground; still known as a *level*, but having an inclination to carry off water, or following the dip of a strata.

In'com-bus'ti-ble Wood, etc.

See FIREPROOFING, p. 339, *supra*, for preparations for

Wood.	Canvas.
Theatrical scenery.	Cordage.
Fabrics.	Straw.
Cloth.	Paper.

In-con'stant Bat'te-ry. (*Electricity.*) A single fluid battery is usually termed *inconstant*, to distinguish it from a two-fluid battery.

In-cor'po-ra'ting Mill. (*Gunpowder.*) A mill on the Chilian principle; two-edge wheels revolving in an annular pan. The materials are ground in water; say 1 gallon to the batch of 50 pounds from the mixing-mill.

See "*Ordnance Report*," 1879, Appendix I., Plate II., Fig. 5, and description on pp. 99-101.

For gunpowder, Br. . . * "*Engineering*," xxv. 37.

In-crust'ed Work. (*Fine Art Metal-working.*) Relief work in metal: from the *crustæ* of the Romans; small ornaments in relief attached to vessels. Distinct from *repoussé*, in which the relief is by beating out the metal.

When the figures were large they were removable and called *emblemata*; like instances seen in *Swami* work, of the Madras Presidency.

India shows many varieties of the work, as silver incrusted on brown copper, copper on brass, traecry, diapering, designs in one metal on another; engraved, chased, or stained by oxidation; tin soldered on brass and incised through in floriated patterns, the ground being in part filled with lac, somewhat like *niello*.

The modern French incrusted bronze, is a copper or bronze with gold and silver ornamentation. The objects are first painted in water colors, the principal ingredient of which is white lead. When several articles are to receive the same drawing, it may be printed in the same manner as in porcelain painting. The places which remain unpainted are varnished. The article is then laid in dilute nitric acid, which dissolves the color and bites the metal on the painted places to the required depth. After washing the article, it is placed in a silver or gold bath, where the free surfaces are electrotyped in silver or gold. The varnish is then removed, and the whole surface is polished so that the gilded and silvered parts are not unduly prominent. The article can then be bronzed. A fine effect is produced with black bronze by sulphuret of copper in the spaces between the gold and silver.

In-cu-ba'tor. An apparatus for the artificial hatching of eggs.

The Egyptian egg-hatching ovens, and the apparatus of M. Bonnemain, of France, are shown and described in the "*Mech. Dict.*," p. 1178.

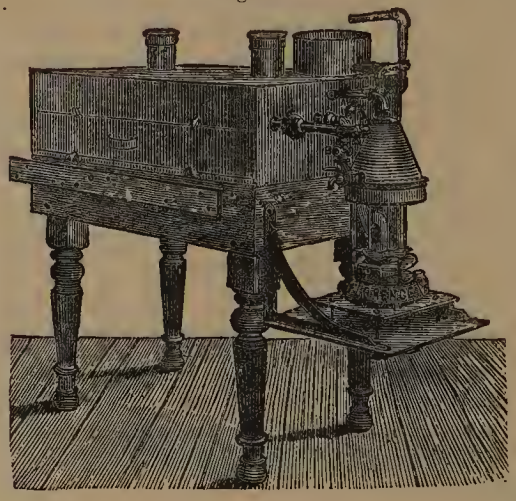
Several late apparatus may be noticed.

Probably each of the following patents has added something to the present approximately successful result. —

Axford.	*Dennis.*
Baker.	*Meyer.*
Day.	*Halsted.*
Cantello.	*Higgins.*
Carbonnier	*Graves.*
Corbett.	*Samuels.*
Weston.	*Thick.*

Fig. 1435 shows the "Reliance" incubator. A steatite radiator is placed over the egg-drawer and heated by hot water pipes imbedded in the steatite. The quantity of water is but

Fig. 1435



"*Reliance*" *Incubator.*

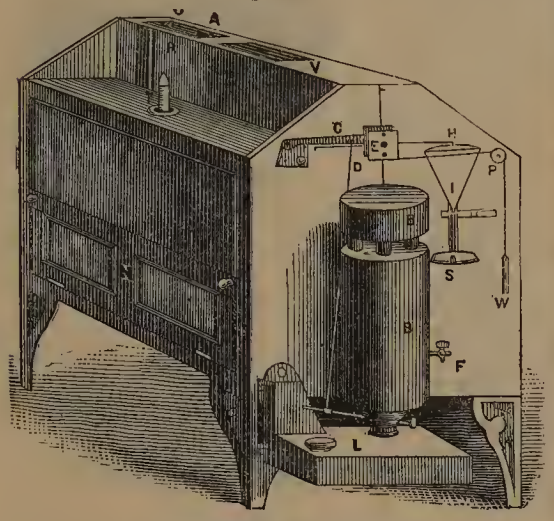
6 quarts for a 300 egg machine. The egg-drawers are separate, each has its ventilator, and receives moisture from an evaporating pan which gives an atmosphere approximating the condition of the natural nest; heat above, and cool, moist air beneath the eggs. The "Florence" oil-stove is used and the burner is so arranged as to obviate the need for other regulator or thermostat.

Halsted's "Centennial" incubator is shown in Fig. 1436, has a boiler, *B*, from which hot water passes to the tank, over which is the reservoir *R* with a glass water-gage. At *O* is the vent for air in filling, and at *F* the faucet for discharge of water when emptying. *V* is the ventilating flue opening into the egg chamber, the glazed door of which is at *N*. The egg drawer is of parallel bars just near enough together to keep the eggs from falling between them. A thermostatic bar in the chamber projects at *S* and operates the foot of the escape lever at *I*, the upper part of which is a spring wire with a narrow opening at *H*. *E* is a reel around which is wound a cord which passes over the pulley *P*, and is attached to the weight *W*. This reel carries four projecting arms, in pairs, the opposite ones of equal length, and a little shorter than the other pair. The ends of these are bent at right angles, so as to catch upon the curved wire section of the escape-lever *I*. This reel is firmly fastened to a shaft passing through to the ventilator flue, and there attached to the ventilator. On the back of this reel-plate are pins which raise or depress the lamp-lever *C*; this is connected with the lamp-trip by the connecting rod *D*.

The thermostatic bar is set or regulated by a set-screw in

the opposite end of the machine. When regulated, the thermostatic bar, affected by the heat, acts upon the lever *I*, bringing the opening *H* over one of the ends of the arms, the force of the weight causes it to pass through and the next arm to cateh, thus opening the ventilator and allowing the hot air to escape, and turning down the lamp. When the

Fig. 1436.

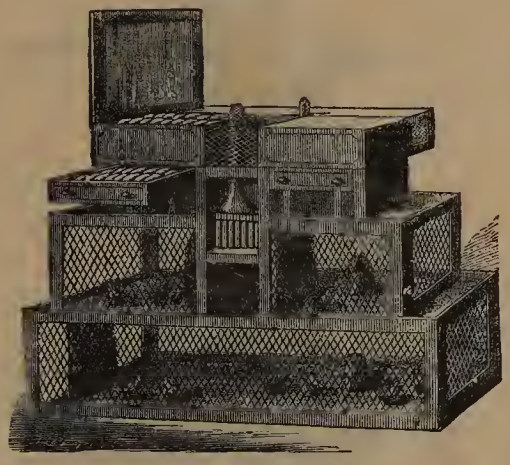


Halsted's Incubator.

drawer has cooled down one or two degrees, the reverse action of the thermostat again releases the end of the arm, and the ventilator closes and the flame is turned up. This is repeated automatically until the weight runs down.

Fig 1437 shows the *Thick* incubator, which has a water reservoir of 10 gallons, heated by kerosene lamp. Air-carrying pipes pass through the heated water, and carry warm air to

Fig. 1437.



Thick's Incubator. (Br.)

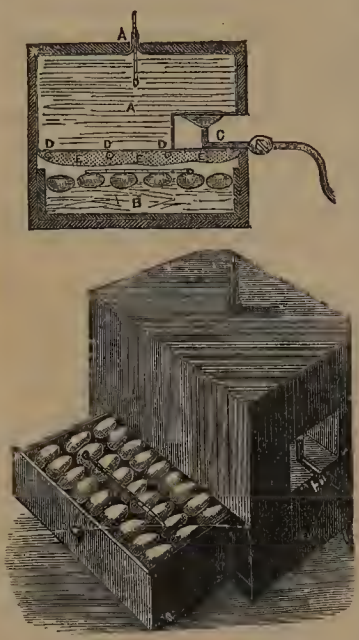
all parts of the hatching apparatus; hot-water boxes form part of the reservoir, under which the chicks, when hatched, are placed to receive the heat necessary for their health. The boxes are covered with a lamb skin, or a "wool mother," the cool, graveled flooring affords for the feet of the chickens a surface similar to natural conditions.

50 eggs are placed in each drawer. The heat of the water reservoir is about 120° Fah., which keeps the eggs at about 103°. The eggs are turned daily and left exposed for 15 minutes, and their relative positions in the drawers changed.

In *Voitellier's* apparatus, shown at the French Exposition of 1878, the heat of the reservoir is kept up by occasional renewals of hot water, and steam is occasionally allowed to escape to keep the atmosphere moist around the eggs.

An improvement on the incubator of *Carbonnier* (Fr.) is shown in Fig. 1438. The apparatus consists of a box, with a zinc case *A* filled with hot water fixed in the top, and underneath a drawer, *B*, to put the eggs in, and in which is spread a quantity of hay, so as to line the bottom of the drawer completely. *C* is a small gas burner sufficient to keep the temperature of the water at 110° Fah., for the eggs

Fig. 1438.

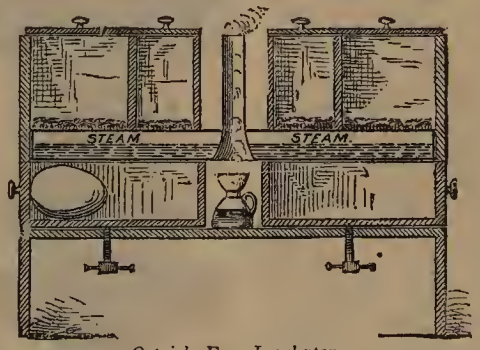


Carbonnier's Incubator.

to become warmed to a temperature of 105° or 104°, to show which a thermometer is laid on the top of the eggs. The upper *A* is a pipe for supplying the basin with water and to receive the thermometer, which is immersed in the fluid, and shows the temperature. *D D D* are three iron rods fixed in from back to front of the box as a support for the zinc case. *E* is a layer of sawdust, suspended by a piece of muslin (or some such thin material) fastened by a few tacks to the inner side of the box, through which the heat passes. The drawer is opened ouce or twice every day to turn the eggs, during the incubation of 21 days.

The "Leviathan" incubator, used in Africa in the artificial hatching of ostrich eggs, was exhibited in the Cape of Good Hope section at the Centennial Exhibition. The apparatus consists of a middle steam chamber of metal, which is kept constantly hot hy a lamp or furnace beneath. Below this are drawers in which the eggs are first placed, and these, by means of the screws shown below, may be raised until the eggs are brought almost in contact with the warm surface above. In these receptacles the eggs are kept for two weeks at a temperature of 102° Fah. They are then removed and placed in the inner pair of compartments, shown above, for another fortnight, at a temperature of 100°. At the end of this period the eggs are carefully extracted, and a small hole is chipped in each shell at the point opposite the chick's head. They are next replaced and kept in the same compartments for two weeks longer at 98°, when the hatching takes place, and the young birds are placed in the outer upper receptacles, and there remain for two days. The compartments above have bottoms of lamb's wool, which come in contact with the steam chamber below.

Fig. 1439.



Ostrich Egg Incubator.

The egg is about 7″ in length, and the hatched chick about 13″ in height. The chick is fed on rice, and when it reaches the age of seven days is worth $50 in gold. Nearly 20,000 hirds, it is said, have been hatched at the Cape of Good Hope by apparatus of this description. The machine is frequently made of sufficient size to hold 115 eggs at a time.

Day's machines are made for 220 and 320 eggs respectively. They are warmed by coal or gas, and the heat is regulated by a thermostat of two unequally expanding metals. This regulates the flame or the draft, as the case may he. An alarm is rung if a given heat be exceeded.

Halsted's "Acme" incubator is entirely of metal, is self-regulating as to heat, and has trays in which the eggs are simultaneously turned, without handling. It is a hot-air machine without boiler or tank. A copper drum is heated by oil lamp, and the warm air radiates from the drum, passing upward through the hot-air chamber where the evaporating

trough divides the current and charges it with moisture. *A* plate deflects the air over the eggs in the drawers. A cool, moist air is retained beneath the eggs. The regulator is a thermostatic bar.

Axford's incubator has a lamp near the floor; circulation from above among the eggs, and exit downward; an electric thermostat and a turn-table holding the trays of eggs; and a special egg-turning arrangement.

Myer's "Perfection" incubator is heated by the ordinary house-stove.

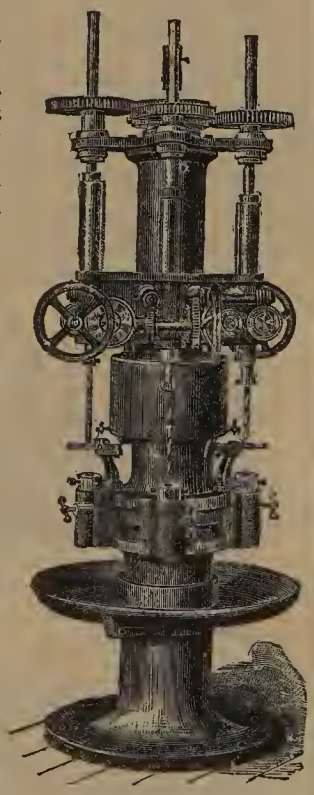
The *Corbett* incubator is placed on a pile of fermenting horse-manure, and more manure piled round if necessary. It is a cylindrical box with trays, each of which has a tier of eggs. The cover is removed and the trays lifted daily and the eggs turned. The apparatus subsequently acts as an artificial mother.

See also:— * "*Scientific American Sup.*," 849.
Carbonnier, Fr. . . * "*Scientific Amer.*," xxxiv. 213.
French . . . . . *Laboulaye's* "*Dictionnaire des Arts*," *etc.*, iii. "*Regulateur.*"
Ostrich, *Douglass* . . * "*Min. & Sc. Press*," xxxvii. 57.
* "*Sc. Amer.*," xxxiv. 226; xxxv. 297; xxxviii. 294, 295.
Ostrich farming . . . "*Scientific American Sup.*," 884.
Thermostat for . . . "*Manufacturer & Builder*," xii. 95.

In'de-pen'dent Air Pump. One having no mechanical connection with the main engine: as distinct from a *connected* air-pump, which is a moving part of the engine. Being a steam-pump, operated independently, a vacuum can be formed for the engine before the latter is started, and the speed regulated according to the temperature of the injection water and the requirements of the engine.

In'de-pen'dent Car Wheel. One running free on the axle; as distinguished from the usual railway car wheel, which is chilled or keyed fast to the axle.

Fig. 1440.



Independent Drill.

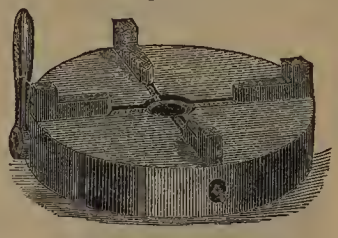
One form of independent car wheel, in which the two wheels are not essentially fast together, so that they can move independently in turning curves, is the *Miltimore* wheel, Fig. 532, p. 163, *supra*. See also CAR-AXLE, pp. 458, 459, "*Mech. Dict.*," and AXLE, pp. 198–201, *Ibid.*

In'de-pen'dent Drill. A machine tool intended for work requiring four drills to finish a hole. Each spindle has independent automatic feed, so that one operator can attend to several machines. The four drills may be respectively a *starting* drill, *through* drill, *enlarging* drill, and *finishing* drill or *reamer*. The piece to be drilled is secured in a holder, indexed perfectly under the drills and finished before removing from its fastening. (*Pratt & Whitney.*)

In'de-pen'dent Jaw Chuck. A chuck in which each jaw is separately adjustable; as distinguished from the *universal*, in which the jaws move in concert. Fig. 1441. See also LATHE CHUCK, *infra*.

In'de-pen'dent Truck. (*Railway.*) One of the 4 or 6-wheeled trucks beneath a railway car on the American system. The car rests on the center pins of the trucks, which can therefore follow the track, swiveling by their own motion while the body of the car takes the position of a chord.

Fig. 1441.



Independent Jaw Chuck.

In the European practice the pairs of wheels are independent and their boxes work in hangers or pedestals on the main sill of the car frame. See Fig. 4126, p. 1863, "*Mech. Dict.*"

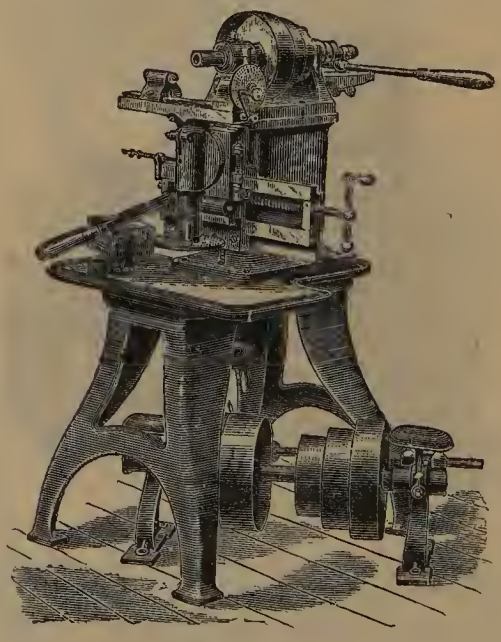
In'de-pen'dent Wheel. A term sometimes applied to a car wheel which runs free on its axle, in contradistinction to the customary wheel, which is chilled, or otherwise tightly fastened to its axle, in the usual railway practice where the wheels are rigidly attached to the respective ends of the axle.

See also a compromise arrangement in which the axle is divided, and each part carries its own wheel, Fig. 532, p. 163, *supra*.

In'dex Mil'ling Ma-chine'. A machine tool adapted to cutting rotary cutters in all varieties, spur and bevel gears, etc.

It receives ordinary work up to 6″ diameter, but will cut spur or bevel gears much larger. The index-plate is attached to the bottom of a hollow spindle having a graduated disk.

Fig. 1442.



Index Milling Machine.

The spindle is pivoted to a vertical slide, and with its attachments, as vise or centers, may be moved to and secured at any angle in a vertical plane of 180°, or 90° on either side of an upright position. This slide, carrying the index, spindle, etc., has a perpendicular traverse of 2″. The upward and downward movement of the main slide, to which the vertical is attached, is 6″, and its side traverse 12″. The centers are shown in the engraving as attached to the index-spindle. They will receive work 3¼″ diameter and 8½″ in length. The cone spindle is of steel, and slides in a cast-iron sheath or shell, which runs in cast-iron boxes lined with babbitt-metal. The horizontal movement of the cone-spindle and the vertical movement of the slides is made by adjustable hand-levers, and limited by check-nuts. (*Pratt & Whitney.*)

In'dex. The following scheme for the filing away of valuable suggestions or data, of a miscellaneous description, or appertaining to any study, science, or what not, was devised some time since by Mr. M. T. C. Gould.

The scheme is for a book of 602 pp. The position of the slip or item is determined by its initial letter and next succeeding vowel, for instances: —

Cyrus, *C. y.*, pp. 145, 146.
Steam, *S. e.*, pp. 462-477.

INDEX RERUM.

Chapter.	Section.	Begins at page.	Occupies pages.	Chapter.	Section.	Begins at page.	Occupies pages.	Chapter.	Section.	Begins at page.	Occupies pages.	Chapter.	Section.	Begins at page.	Occupies pages.
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	e	7	8		*e*	235	4		*e*	335	2		*e*	518	4
A	*i*	15	10	G	*i*	239	4	M	*i*	337	4	T	*i*	522	6
	o	25	6		*o*	243	2		*o*	341	8		*o*	528	14
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44	*a*	35	12	22	*a*	247	6	16	*a*	351	2	6	*a*	548	2
	e	47	10		*e*	253	4		*e*	353	4		*e*	550	2
B	*i*	57	4	H	*i*	257	4	N	*i*	357	4	U	*i*	552	½
	o	61	10		*o*	261	6		*o*	361	4		*o*	552	½
	u	71	6		*u*	267	1		*u*	365	1		*u*	553	½
	y	77	2		*y*	268	1		*y*	366	1		*y*	553	½
68	*a*	79	24	11	*a*	269	2	11	*a*	367	2	11	*a*	554	6
	e	103	6		*e*	271	4		*e*	369	4		*e*	560	1
C	*i*	109	6	I	*i*	275	2	O	*i*	373	2	V	*i*	561	1
	o	115	24		*o*	277	1		*o*	375	1		*o*	562	1
	u	139	6		*u*	278	1		*u*	376	1		*u*	563	1
	y	145	2		*y*	279	1		*y*	377	1		*y*	564	1
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	e	153	6		*e*	282	1		*e*	392	10		*e*	571	4
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	o	163	4		*o*	284	4		*o*	410	6		*o*	587	4
	u	167	4		*u*	288	1		*u*	416	4		*u*	591	1
	y	170	2		*y*	289	1		*y*	420	2		*y*	592	1
28	*a*	173	10	11	*a*	290	2	28	*a*	422	4	2	*a*	593	¼
	e	183	8		*e*	292	4		*e*	426	6		*e*	593	¼
E	*i*	191	6	K	*i*	296	2	R	*i*	432	4	X	*i*	593	¼
	o	197	2		*o*	298	1		*o*	436	10		*o*	594	¼
	u	199	1		*u*	299	1		*u*	446	2		*u*	594	¼
	y	200	1		*y*	300	1		*y*	448	2		*y*	594	¼
20	*a*	201	4	18	*a*	301	4	60	*a*	450	12	2	*a*	595	¼
	e	205	6		*e*	305	4		*e*	462	16		*e*	595	¼
F	*i*	211	6	L	*i*	309	4	S	*i*	478	20	Y	*i*	595	¼
	o	217	10		*o*	313	4		*o*	498	10		*o*	596	¼
	u	227	1		*u*	317	1		*u*	508	1		*u*	596	¼
	y	228	1		*y*	318	1		*y*	509	1		*y*	596	¼
								Q	*u*	597	4	Z	*a-y*	601-2	2

In'dex Plate. For gear cutting machines. The face has a number of circles each with a certain number of holes so that any required number of teeth may be made on a wheel, the circle being divisible by that number.

SIZES OF BROWN & SHARPE'S INDEX PLATES FOR GEAR CUTTING MACHINES.

Diameter of Plate.	Number of Circles.	Number of Holes in Smallest Circle.	Number of Holes in Largest Circle.	Whole Number of Holes.	Divides all Numbers to.	Divides all Even Numbers to.
12 in.	25	52	100	1,900	50	100
16 in.	38	76	150	4,294	75	150
20 in.	50	102	200	7,550	100	200
24 in.	63	126	250	11,844	125	250
28 in.	75	152	3 0	16,950	150	300
32 in.	90	182	360	24,390	180	360

In'dex Wheel. 1. A graduated plate marked in circles of holes, for spacing in the cutting of gears. See INDEX PLATE; INDEX MILLING MACHINE.

2. A graduated wheel in an instrument for dividing or measuring angles, or in some forms of calculating instruments.

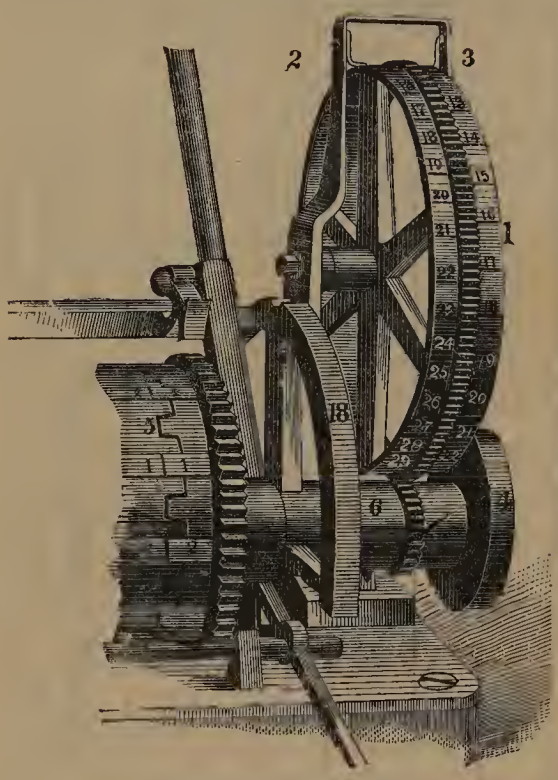
An index wheel in the set works of a saw-mill is shown in Fig. 1442.

1 is the index wheel.
2 and 3, pointers.
4, coupling to which the set rod for working the knees is connected.
6, cog for working the index wheel.
18, support for the index wheel.

The object of the device is to tell at any time the exact number of inches in any log on the carriage, between the knees and the saw. Also, to tell how much slab must be taken off the first cut, in order to have the lumber in the remainder of the log all come out of the required thickness.

In'di-a Ink. The best India ink is still made in China, although its quality has deteriorated since glue made of buffalo instead of stag's horn has

Fig. 1443.



Index Wheel for Saw-logs.

been employed as the vehicle for the lampblack. Its first invention is reported to have been between A. D. 220–419. — "*Scientific American*," xxxvi. 25.

In'di-a Rub'ber. See CAOUTCHOUC.

In'di-a Rub'ber Spring. 1. (*Railway.*) A block of caoutchouc, usually cylindrical, and used in connection with steel springs, either as truck springs or for buffers and draw-springs. See Figs. 1142–1144, pp. 482, 483, "*Mech. Dict.*"

2. (*Carriage.*) A spring used in connection with the ordinary elliptic springs in the running gear, or as a bumper spring between the bolster and bed of a wagon.

3. A strap of rubber used for a return motion in many species of light machinery.

In'di-ca'tor. A marker of phenomena; time, place, number, distance, recurrent position or presence, etc.

There are many instruments cited as GRAPHS, METERS, SCOPES, etc. (see said titles in "*Mech. Dict.*"), which are indicators; such as, to cite one class of limited area, a *Gas Indicator*, of which *Fire-damp Alarm*, *Grisoumeter*, *Carburometer*, are specific titles.

See list of MEASURING, CALCULATING, AND INDICATING INSTRUMENTS, *infra*.

A list of speed, course, grade, and distance indicators and recorders is given on p. 282, *supra*.

Steam, electric, and other indicators are shown on pp. 1180, 1181, "*Mech. Dict.*," and the same work contains in their alphabetical places notices of the following indicators: —

Door.	Shoal.	Stream.
Leak.	Speed.	Street.
Leeway.	Station.	Weather.

See also: —

Channel depth, *Echebarn & Durgos*, Brazil . . * "*Scientific American Sup.*," 1522.
Diagrams, *Martin* . . * "*Railroad Gazette*," viii. 55.
Eye-piece of microscope * Fig. 997, p. 323, *supra*.
Gas . . . . . * "*Scientific American Sup.*," 1615.
Guiding pulley for.
Stanek, Aus. . . . * "*Engineering*," xxv. 65.
Motion, *Bowsher* . . . * "*American Miller*," iv. 30.
Station . . . . . "*Scientific American Sup.*," 865.
Steam, detent for.
Darke, Br. . . . . * "*Engineer*," xli. 69.
Steam engine, *Thompson* * "*Scientific Amer.*," xxxv. 278.

In'di-rect' Point'ing Ap'pa-ra'tus. (*Ordnance.*) The piece being once suitably adjusted by means of direct observations, the graduation of certain plates is observed, and subsequently the piece being marked, the piece is adjusted according to the graduations. See POLEMOSCOPE.

See cut and description of the Prussian apparatus used in the sieges of the war 1870, 1871, at Strasbourg and elsewhere. "*Revue d'Artillerie*," iii. 2, and translated in "*Ordnance Report*," 1878, Appendix L, p. 107.

See also ALTISCOPE, * Fig. 136, p. 69, "*Mech. Dict.*"

In-duced' Cur'rent. (*Electricity.*) A current of electricity generated in a coil of wire by induction.

In-duc'tion Ap'pa-ra'tus. See *infra*, also —

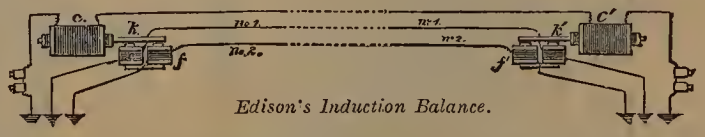
Apparatus { * *Faraday* / * *Forbes* } "*Scientific Amer. Sup.*," 742.
Balance, *Edison* . . . . * "*Engineer*," xlvii. 284. U. S. Pat. 203,019, Ap. 30, 1878.
Hughes . . . . . * "*Engineering*," xxvii. 219, 419, 458. * "*Scientific American*," xl. 244.
Coil, *Hopkins* . . . . * "*Scientific Amer. Sup.*," 2548.
Inductorium, *Apps* . . * "*Teleg. Journal*," * v. 31, 151.
(Large) . . . . . * "*Scientific Amer. Sup.*," 3647. * "*Engineering*," xxiii. 303.
Eng. . . . . * "*Scientific Amer. Sup.*," 1173.

In-duc'tion Bal'ance. An instrument for the eradication of induction currents in telegraph lines.

Edison's induction balance, patented in England in 1877, and in the United States in 1878, was designed, in the terms of its specification —

"To compensate, neutralize, and destroy the extraneous or induced currents from contiguous circuits, so that the messages will not be in any manner interfered with by false currents. The invention consists, in the combination with the telephonic circuit, of an induction coil, connected with the contiguous circuits in such a manner that a reactionary induction is established in the telephonic line of a power corresponding and similar to the primary inductive action, but opposed to the same, so as to neutralize the action of the same."

Fig. 1444.



Edison's Induction Balance.

Fig. 1444 is "a diagram representing one of the forms in which the compensation is effected. The large coils, c c', are included in the telephonic circuit at each end of the line. In the coils are iron cores, surrounded by a primary coil, the ends of which may or may not be connected together, according to the compensation desired.

"The iron core extends outside of the coils some distance. The circuits, No. 1 and No. 2, running in close proximity to the telephone wires, induce a momentary current in it every time the circuits are opened or closed, the strength of which is proportionate to the proximity of the wires to each other and the number of miles that they run side by side. These induced currents are in one direction in closing the circuit, and the opposite direction on opening the circuit. To neutralize the induced current from, say, No. 1 circuit, electromagnets, e e', are placed at each terminal in the circuit of No. 1.

"These magnets are then adjusted to approach the iron cores, k k', until the induced current thrown into the coils, c and c', and telephone line by the action of the magnets, e and e', is equal, but opposite to, the induced current from the circuit No. 1 thrown into the telephonic wire by running parallel to it. Thus a perfect compensation is attained.

"If the two lines run parallel for long distances the two ends of the primary coil on c and c' are connected together, and thus retard the magnetization and demagnetization of the cores, k k', and consequently lengthen the induced currents thrown into c and c' by the action of e' and e.

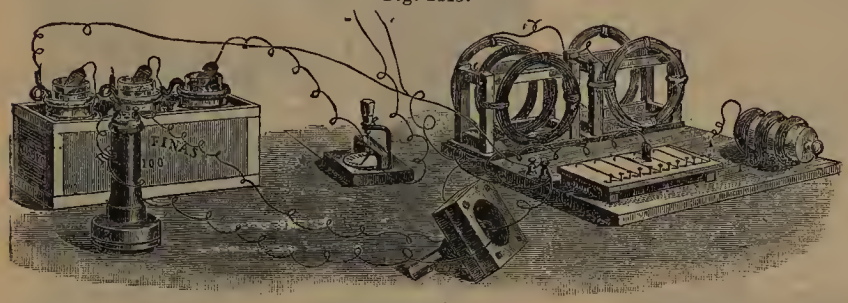
"Having thus compensated for circuit No. 1, the compensation for circuit No. 2 is exactly similar. If the latter circuit does not affect the telephone circuit as strongly as No.

1, the electro-magnets, *f* and *f'*, are placed a greater distance from *k* and *k'*; the latter may be elongated, and compensation attained from many circuits by employing separate magnets in each circuit which affects the telephonic circuit."

Fig. 1445 shows Prof. Hughes' apparatus. It consists of coils of wire, a telephone, a microphone, a three-cell Daniell battery, and a galvanometer, and was constructed by Prof. Hughes, to practically demonstrate his principle of compensation. The subject is carefully described, and the principles of the apparatus well treated in "*Engineering*," March 14, 1879.

"The five rings of insulated iron wire attached to the board — on the right, in the perspective view, Fig. 1445 — represent three lines of telegraph running parallel. The

Fig. 1445.



Hughes' Induction Balance.

two coils of each of the outside pair are joined so as to form one circuit, consisting of one black ring and one white one, each pair representing one line of a certain length, and between them is a single coil representing an intermediate telegraph line of a shorter length; this differeuce of leugth was adopted by Professor Hughes in his experimental model in order to represent a somewhat complicated case, and to show that no matter what the relative lengths and distances apart of telegraph lines, their mutual induction may be compensated by suitably constructed and adjusted compensating coils. The compensation portion of the apparatus consists of three rings whose distances apart can be adjusted by sliding in or out the cylinder to which each of the outer coils is attached. On the left front corner of the board is the commutator, consisting of six stiff elastic wires, which can be sprung against twelve brass nails, and the connections are so arranged that the battery circuit may be sent through any one of the lines, with or without the balance in the circuit, and each line can be made either a primary microphone circuit, or a secondary line in connection with a telephone, by simply placing the commutator wires against their proper contact pins. The microphone, and the clock (not shown), which is the source of sound, were, in the professor's experiments, placed in a distant room, and the direction of the currents throughout the whole apparatus was under perfect control by means of the commutator to which we have referred." — "*Engineering*."

In'duc-tom'e-ter. An invention by Dr. O. J. Lodge (England). A modified form of induction balance fitted for electric testing.

"*Engineering*" . . . . . * xxx. 134.

In-duc'to-phone (*Electricity.*) A sounding instrument in which vibratious transmitted through the primary are reproduced by a plate and membrane. *Adams.*

"*Telegraphic Journal*" . . . . . vi. 30.
"*Journal Society Telegraph Engineers*" . . . . * vi. 476.

In'duc-to'ri-um. The carrier of an induced current. — *Ganot.*

Subject considered,* with notices of Ruhmkorff, Bréguet, Masson, Fizeau, Neef, De la Rive, Verdu, Savart, Moncel; *Laboulaye's* "*Dictionnaire des Arts et Manufactures*," article "*Induction*," tome iv., ed. 1877.

Hopkins . . . * *Scientific American Supplement*," 2548.

In-fer'nal Ma-chine'. A name applied to Fieschi's battery of gun barrels with which he attempted to assassinate Louis Philippe.

Thomasson . . * "*Engineer*," xli. 23.
"*Scientific American*," xxxiv. 65.
* "*Scientific American Supplement*," 149.

In'fil-tra'tion. (*Mining.*) The theory that vein filliug was introduced as mineral water.

In'fu-so'ri-al Earth. A species of earth, the remains of microscopic animals. It is used as an ingredient in dynamite. See p. 767, "*Mech. Dict.*"

Infusorial earth, uses of, "*Scientific American*," xxxv. 240.

In'grain. As applied to carpets, ingraining is the union, according to the necessity of the pattern, where an interchange of yarn occurs between the *plies* or webs. The more frequently this occurs the better the fabric is *ingrained.*

The ingrain carpet may be *two-ply*, *three-ply*, etc., according to the number of webs.

In-jec'tion. (*Mining.*) The theory that veiu filling was introduced by au igneous fluid and solidified. See IMPREGNATION.

In-ject'ing Syr'inge. (*Microscopy.*) An instrument for injecting the minute arteries of animal tissues with colored chemical substances, thus filling the small blood-vessels and rendering them visible under the microscope.

In-jec'tor. 1. (*Surgical.*) An instrument of the nature of a syringe. The size and shape and the form and proportions of the nozzle vary with the object.

They may be classed as

Bladder.	Rectum.
Embalming.	Uterus.
Hypodermic.	Vagina.

Dr. Parker's injection tubes for the urethra are bulb-pointed, soft rubber, velvet-eyed.

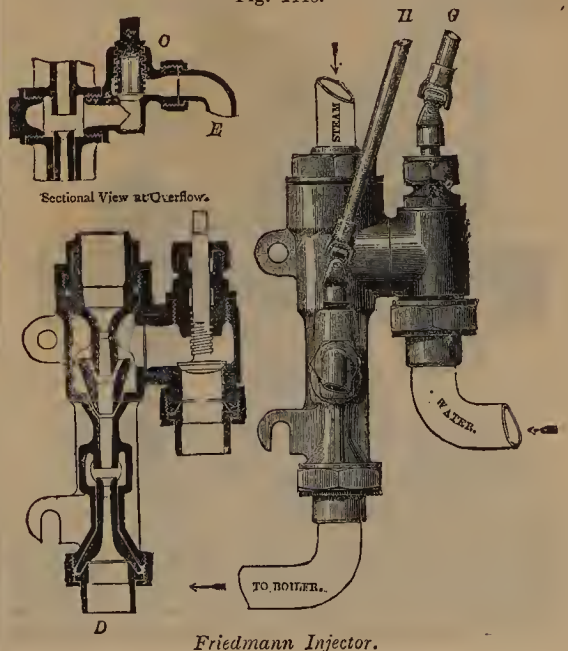
Many other instruments with specific names have the same function, such as *Eustachian Canal Injector*, *Double-current Catheter*, *Bladder-washing Apparatus.*

Syringe, douche, irrigator are nearly synonymous.

The embalming of bodies by thymol injection is the subject of a pamphlet by Dr. Wywodzoff, of St. Petersburg, Russia, Philadelphia, 1876, and the recipe has been cited under EMBALMING, p. 311, *supra.*

2. The injector as a device to feed water into boil-

Fig. 1446.



Friedmann Injector.

ers has been described on pp. 1185, 1186, "*Mech. Dict.*" *Giffard's*, and *Seller's* improvement on Giffard, are there shown, Fig. 2679.

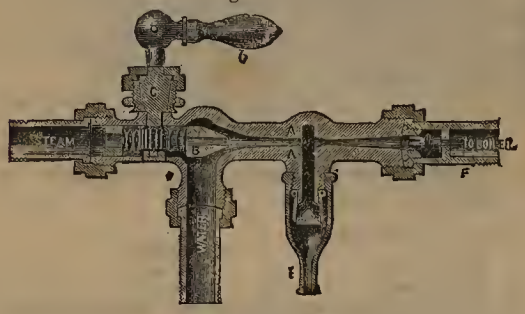
Various modifications and applications of the device are now found.

Fig. 1446 shows the Friedmann (Nathan & Dreyfus) non-lifting injector for locomotives. It is to be placed below the water line and can be used as a heating cock for the tender and water-tank by closing the overflow valve, the handle of which extends into the cab.

H is the handle of the overflow valve, to be used to close the overflow altogether or when the injector is to be used as a heater-cock to heat the water in the tender. *G* is the handle of the water valve; the latter is seen to the right in the sectional view. On the left, in the sectional view, is the intermediate nozzle by which the water supply is conducted in two annular streams to the condensing chamber of the injector when the steam jet is subjected to the action of both at separate points. The result is effective condensation of steam and the transfer of its velocity to the water.

Fig. 1447 is the "Keystone" injector. The form shown is used when the supply water is received from a pressure, such as street main or elevated reservoir. It is placed in a horizontal position, the steam pipe attached to highest part of the boiler, an ordinary globe valve being placed on the steam pipe, and a valve or water cock on the water pipe.

Fig. 1447.

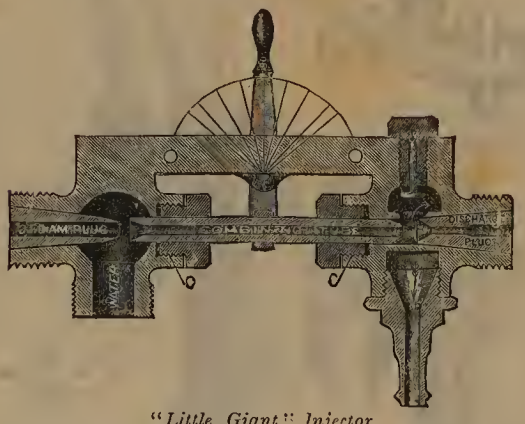


"*Keystone*" *Injector.*

Method of working: Open the steam valve to drive out any condensed steam there may be in the pipe, and close it again. Then open the water cock, then the steam valve, and move the plug *B* slowly forward with the handle *b*, until the water ceases at the overflow. If, while the injector is working, water should escape from the overflow, move the plug forward to reduce the supply of water. If steam escapes, move the plug backward, to give it more water. When the lever *b* is set so the injector works perfectly dry; if you wish to stop feeding, close first the steam valve, then the water cock.

Rue's "Little Giant" injector has an adjustable *combining-tube* moved by a lever. The motion to the left, as exhibited in the cut, Fig. 1448, gives more water, and contrariwise, less. The injector cannot be worked while the combining-tube is closed at either end. The injector lever should be in such posi-

Fig. 1448.

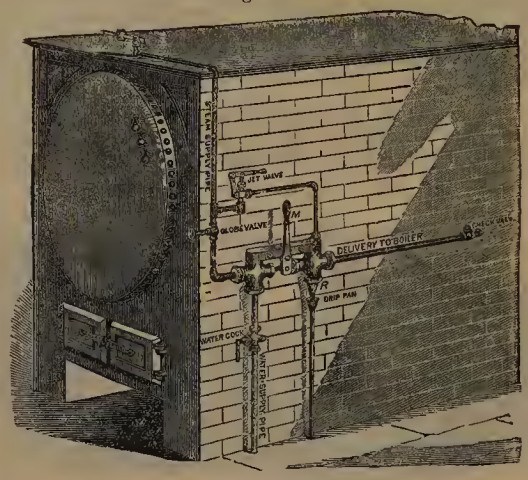


"*Little Giant*" *Injector.*

tion as to allow a sufficient quantity of water to condense the steam when the valve is full open. The combining-tube being open at each end slides in stuffing boxes *C C*, on the left towards the steam supply pipe which projects into the water chamber, and at the other end the tube projects into the discharge chamber to meet the discharge tube which leads to the boiler. The space around the tubes, what may be called the second chamber, has an overflow valve which allows escape of water in the direction of the arrows, when the force of the steam has not sufficient force to cause the water to open the check valve in the boiler supply pipe beyond the discharge plug. When the water has sufficient momentum to open the check valve it causes an indraft at the overflow pipe which closes the valve against the ingress of air.

Fig. 1449 shows the "Little Giant" injector attached to a stationary boiler. The parts are indicated in the cut.

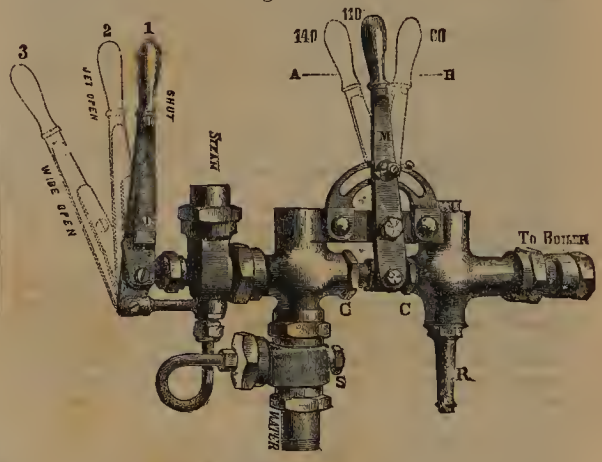
Fig. 1449.



"*Little Giant*" *Injector attached to Stationary Boiler.*

Fig. 1450 shows the arrangement of the *Rue* "Little Giant" injector as applied to locomotives. Directions for operating will sufficiently explain it in connection with what has been previously stated.

Fig. 1450.



Rue Locomotive Injector.

To start the injector: Open lever valve from 1 to 2; when water shows at overflow *R*, open valve to 3 where it must remain while the injector is at work. Regulate water by the combining-valve lever *M*.

To stop the injector, close the valve 4.

To use as a heater: Close overflow by moving lever *M* to *A*. Then open lever valve on the left to 2 or 3 to admit steam required.

See also INSPIRATOR.

See Austrian . . . . . * "*Engineering*," xxvi 86.
Condenser, *Bulkeley* . . . * "*Engineer*," xlvii. 332.
Friedmann . . . . . * "*Sc. American Sup.*," 655.
* *Thurston's "Vienna Expo. Rept.*," ii. 138.
Hydrants for fire extiuction.
Greathead, Br. . . . . * "*Engineering*," xxviii. 80.
Gresham & Craven (16 Figs.), Br. . . . . * "*Engineer*," xliii. 134.
Gresham & Craven, Br. . . * "*Engineer*," xlix. 35.
Hall . . . . . * "*Sc. American Sup.*," 2436.
Hart, Engl. . . . . * "*Sc. American Sup.*," 1779.
Steam, *Irwin* . . . . . * "*Man. & Builder*," xii. 132.
"*Iron Age*," xxv., Mar. 25, 1.
Locomotive, *Körting*, Br. . . * "*Van Nostr. Mag.*," xvi. 419.
Körting, Engl. . . . . * "*Sc. American Sup.*," 897.
Körting, Br. . . . . * "*Engineering*," xxii 474.

"Clipper," *Lynde* . . * "*Scientific Amer.*," xl. 37.
Locomotives, *Mazza*, Italy * "*Engineering*," xxvii. 24.
Hot water for locomotives.
Mazza . . . . . "*Iron Age*," xxiii., Feb. 13, p. 9.
Steam, on, *Pochet* . . . . * "*Van Nostrand's Mag.*," xvi. 209; * 341.
Principles . . . . . "*Sc. American*," xxxviii. 325.
Sam, Br. . . . . * "*Engineer*," xlviii. 462.
Sellers . . . . . * "*Railroad Gaz.*," xxi. 323.
* "*Iron Age*," xix., June 7, p. 26.
Steam, *Westley* . . . . * "*Sc. American*," xxxvi. 355.
"Eclipse," *Wilde* . . . * "*Sc. Amer.*," xxxviii. 290.

Chas. E. Emery's report in "*Centennial Exhibition Reports*," vol. vi., Group XX., refers to —

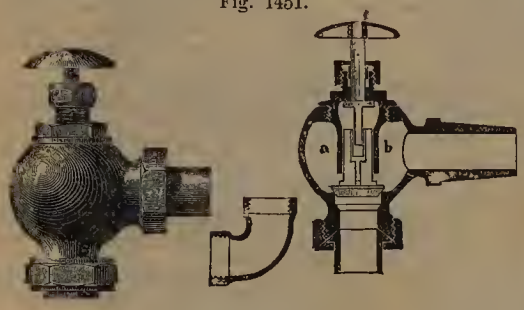
Sellers . . . . . * vi. 376.
Friedmann . . . . . * vi. 377
Nathan & Dreyfus . . . . . * (ejector).

Treatise on *Giffard's*, *Laboulaye's* "*Dict. des Arts et Manufactures*," article "*Injecteur*," tome iv., ed. 1877.

Leon Ponchet, "*Steam Injectors.*" (From the French.)

In-ject'or Check Valve. The valve in the water supply pipe, between the injector and the

Fig. 1451.



Injector Check Valve.

boiler, rising to admit the water under impulse of the steam jet, and falling to prevent back flow of water.

Ink.

Yellow: A little alum, added to saffron in soft hot water.

For tin or zinc plant labels: Copper, 1; nitric acid, 10; water, 10, subsequently added.

Stencil ink: Shellac, 2; borax, 1; soft water, 10; boil. Add gum arabic, 1; remove from the fire, and stir in lamp-black *ad suf.* Indigo added to tinge.

For tin or zinc: Sulphate of copper, 1; sal ammoniac, 0 5; acetic acid, 2; add lamp-black or vermilion.

Blue: Sulphate of indigo, diluted with water.

To restore faded ink: Brush over with a solution of sulph'de of ammonium.

Or: Brush with solution of tannin, remove excess by current of water, and dry at 144° to 177° Fah.

Or: Brush over with solution of sulphocyanide of potassium 1 in 20, and dry in fumes of hot hydrochloric acid Ferro-cyanide might answer.

To remove ink marks: Moisten with solution of cyanide of potassium, and then solution of oxalic acid. Apply with a camel's-hair brush alternately.

Sympathetic: —

Material.	Treat with.	Result.
Sol. bichr. potas.	Logwood extract.	Black.
Yellow ferrocyan. pot.	Sulph. iron.	Blue.
Yellow ferrocyan. pot.	Sulph. copper.	Red brown
Salt of arsenic.	Sulph. acid vapor.	Yellow.
Salt of antimony.	Sulph. acid vapor.	Orange.
Nitr. or chl. nickel.	Heat.	Green.
Nitr or chl. cobalt.	Heat.	Red.
Chl. copper.	Heat.	Blue.

See list also on p. 1187, "*Mech. Dict.*"

Japanese writing inks are very much like Chinese, and manufactured in a similar, though perhaps not quite identical way. The body of the ink is soot, obtained from pine wood or rosin, and lampblack from sesamum oil for the finest sort. This is mixed with liquid glue made of oxskin. This operation is effected in a large round copper bowl, formed by two spherical calottes, placed 1″ apart, so that the space between can be filled up with hot water to prevent the glue from hardening during the time it is mixed by hand with the lampblack. The cakes are formed in wooden molds, and dried between paper and ashes. Camphor, or a peculiar mixture of scents, which comes from China, and a small quantity of carthamine (the red coloring substance of safflower), are added to the best kinds, for improving the color, as well as for scenting the ink. There is a great difference in price as well as in quality between the various kinds of ink, the finest article being rather costly. The most renowned manufactory is in Nara, the old capital of Japan, in the province of Yamato.

Black, Austrian . . . . "*Scientific Amer. Sup.*," 708.
Chromic . . . . . "*Sc. American*," xxxv. 298.
Copying . . . . . "*Sc. Amer. Sup.*," 708, 1975.
Indelible . . . . . "*Sc. American*," xxxiv. 361; xxxv. 52; xxxviii. 96.
Invisible for postal cards . "*Sc. American*," xxxvi. 20.
Logwood . . . . . "*Sc. American*," xxxv. 101.
Pencil . . . . . "*Sc. American*," xli. 228.
Powder and tablet . . . "*Scientific Amer. Sup.*," 708.
Inkstand, Railway . . . * "*R. R. Gazette*, xxiv. 706.
Sympathetic . . . . . "*Sc. American*," xxxix. 377.
Long list of inks . . . . "*Scientific Amer. Sup.*," 2498.
Ink cartridges and solid ink "*Sc. American*," xxxvii. 112.

A variety of recipes and colors are given in *Laboulaye's* "*Dict. des Arts et Manufactures*," vol. ii., cap. "*Encre.*"

Ink Cup. A vessel hermetically closed, to hold water color or liquid india ink, to preserve it from evaporation and from flies.

Fig. 1452.

India Ink Cup.

The stopper is removed, and the ground ink (or color) is placed in the cup through the tubular neck. Replace the stopper and tube. Pressure on the bladder cover causes the ink to rise in the tube, so as to be within reach of the pen.

Ink'er. The device on a recording instrument which makes the dot or trace.

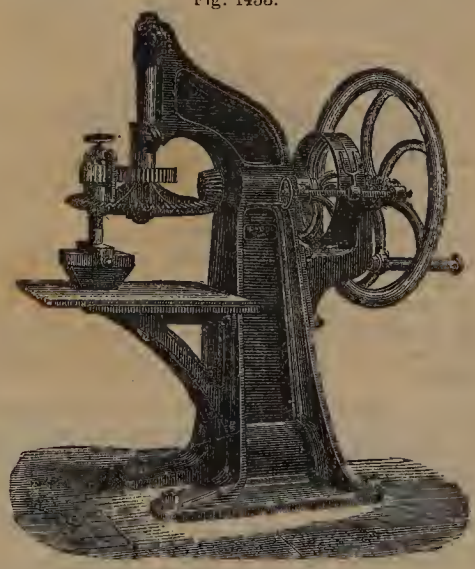
John inking disk, for telegraphic instrument, English, 1856.

Devos inker . . . * "*Telegraphic Journal*," vi. 28.

Ink E-ra'ser. Take chloride of lime 4 ozs., dissolve in 1 quart of soft water. When dissolved, strain, and add a teaspoonful of acetic acid to each ounce of chloride lime-water. Apply to ink with a brush; absorb moisture with blotter, and dry.

Ink Grind'ing Ma-chine'. A machine having muller and table for grinding ink or color. The

Fig. 1453.



Ink Grinding Machine (Fr.).

table is level, and the muller has a rotation and revolution thereon, its vertical axis being journaled in the rim of a wheel, which is revolved by pinion on the main shaft.

Ink'ing Pad. A pad used to ink the faces of post-office canceling and office stamps.

The Yale pad has a metallic cup, a porous ink surface, and a cover to protect it when not in use.

Ink Pen'cil. A pencil giving a black mark which does not fade on exposure to light, and can be reproduced in the copying machine.

"The mass for these pencils is prepared as follows: 10 lbs. of the best logwood are repeatedly boiled in 10 gallons of water, straining each time. The liquid is then evaporated down till it weighs 100 lbs., and is then allowed to boil in a pan of stone-ware or enamel. To the boiling liquid nitrate of oxide of chrome is added in small quantities, until the bronze-colored precipitate formed at first is redissolved with a deep blue coloration. This solution is then evaporated in the water bath down to a sirup, with which is mixed well-kneaded clay in the proportion of 1 part of clay to 3½ of extract. A little gum tragacanth is also added to obtain a proper consistence.

The nitrate of oxide of chrome is prepared by precipitating a hot solution of chrome alum with a suitable quantity of carbonate of soda. The precipitate is washed till the filtrate is free from sulphuric acid. The precipitate thus obtained is dissolved in pure nitric acid, so as to leave a little still undissolved. Hence the solution contains no free acid, which would give the ink a dirty red color. Oxalic acid and caustic alkalies do not attack the writing. Dilute nitric acid reddens, but does not obliterate the characters." — *Moniteur Scientifique.*

Ink Pow'der.

Aleppo galls	3 lbs.
Copperas	1 lb.
Gum arabic	½ lb.
White sugar	¼ lb.

Powder and mix. 1 pint boiling water to 2 oz. of this mixture makes a good ink.

Ink, Solid. One recipe for solid ink is: —

Honey	8 oz.
Egg	1 yolk.
Extr. galls	1½ pints.
Sugar candy	1 oz.
Gum arabic	3 oz.
Indigo	1 oz.
Decoc. logwood	½ pint.
Lampblack	2 oz.
Willow wood charcoal	2 oz.
Sulphate iron	3 oz.
Blue galls in powder	3 oz.

Another recipe is: —

Catechu	3 drachms.
Extr. hæmatoxylon	1 drachm.
Acetate and hydr. of deutoxide copper	10 grains.
Sulph. alumina and potash	1 scruple.
Gum arabic	1 drachm.
Sulph. of protoxide of iron	1 drachm.
Sulp. indigo, for color.	

Over all pour a decoction of Campeachy wood to form a paste.

Ink'stand. A solid-ink inkstand is one furnished with a block of ink which affords a writing fluid by addition of water. See *supra.*

In-lay'ing. (*Fine Art Metal-work.*) The inlaying of Japanese bronzes with gold, silver, and alloys is called *zogan*, and is principally carried on in the provinces of Kaga and Yechiu. The process by which the inlaid work is effected differs according to the nature of the material on which it is produced.

Cloisonné. The design is hollowed out to a certain depth with a graver or chisel, and the ornamenting metal, silver, gold, etc., generally in the shape of threads, is laid into the hollow spaces and hammered over, should the alloy be soft enough; the edges of these grooves are first slightly driven up, so that when the silver or gold has been laid in, they can be easily hammered down again, so as to prevent the inlaid metal from getting loose.

Or: The surface is merely covered in the required places with a narrow network of lines by means of filing, and the thin gold or silver-leaf fastened on to this rough surface by hammering. This last process is the one used mostly for inlaid iron-work. With *Niello*, instead of the usual black sulphureted silver and copper, a more easily fused alloy is used. Inlaid work of the above kind is made at Kauasawa and Takaoko, where the alloy used for the bronze casting is mostly composed of copper, tin, zinc, and lead.

In the European practice the inlaid enamel work which is performed by Oriental artists with so much skill and patience, and at the same time with such primitive appliances, is now executed by simpler and quicker means. The object to be inlaid is entirely covered with varnish, portions of which are removed by a graver so as to form the design; and thus prepared, it is subjected to the action of a galvanic bath of gold or silver, which deposits the metal in the places laid bare by the graver.

Another method is suggested by M. Morin. After the removal of the varnish, according to the pattern made by the graver, the object is plunged into a solution of cyanide of silver. The salt is deposited on the lines from which the varnish has been removed; the object is heated in a muffle furnace, and the metal appears on the black patina.

Inlaid patterns of gold and silver may be obtained, either of their natural brightness or with a dead surface, the latter being effected by different processes of oxidation; so that, on the same object, by making use of the protecting varnish, designs in gold and silver of various degrees of luster may be combined.

See also "*Manufacturer and Builder*" . . . . xi. 34.

Japanese *repoussé* work consists of small metallic ornaments for swords, tobacco pouches, etc., and larger pieces, such as tea-pots, scent-burners, vases, etc.; the inlaying of this kind of ware is sometimes of extraordinary delicacy and beauty. The dark blue color shown by a great number of smaller pieces is that of the Shakudo, composed of copper and 3 or 4 per cent. of gold.

India excels in inlaying, and has many styles, the names of some of which have been recognized in commerce, arts, or in treatises. The art, which was common in Europe, is said to have been introduced from Persia into India about a century ago.

Bombay inlaid work is used for boxes, desks, and similar articles.

Vizagapatam work is in ivory and stag's horn, and applied to articles similar to the Bombay work. The black etched scroll work on the ivory is in graffito.

Mynpuri work consists of boxes and salvers of a rich brown wood, inlaid with brass wire in geometrical forms and scroll patterns.

Agra work is a mosaic of semi-precious stones, copied in style from the exquisite Taj at Agra by Austin de Bordeaux.

See also BIDIRI WORK; KUFT WORK.

In'ner-hung Brake. (*Railway.*) One in which the brake shoes and beam are hung between the wheels, under the car-bed. In contradistinction to *outer*-hung brake.

In Place. (*Mining.*) A vein or lode inclosed on both sides by fixed and immovable rock.

In'sect De-stroy'er. A means for destroying aphides, slugs, and bugs on roses or other flowers and plants; beetles on potatoes; worms on cotton, and so on.

See SIFTER; DUSTER; SPRAYING MACHINE; FOUNTAIN PUMP; SPRINKLER; BEETLE-DESTROYER.

Comstock's "*Report upon Cotton Insects*," 1879, shows a great number of devices, which are listed under COTTON-WORM DESTROYER, p. 226, *supra.*

See also decoction tomato stems "*Sc. American*," xli. 168.
Powder blower, *Marks* . . . * "*Sc. Am.*," xxxviii. 278.
Grasshopper machine . . . . "*Iron Age*," xix., June 28, p. 11.
Riley . . . . . * "*Sc. Amer.*," xxxvii. 169.

In'sect Pin. A delicate, thin pin for impaling entomological specimens.

In-sert'ed Joint. A form of pipe joint in which one member slips in the other, which forms a sleeve. A bell-joint.

In-side'-jaw Chuck. A chuck for holding drills, rods, or pipes. These pass *through* the chuck, the jaws of which have an inside hold instead of, as in a face-chuck, gripping the object by projecting jaws, as in the ordinary lathe chuck.

In-side' Mold'ing Ma-chine'. 1. A wood-planing, molding, or matching machine, the cutters of which are between the bearings of the cutter arbor; in contradistinction to a machine in which the cutter overhangs the frame.

2. A wood molding machine which has cutters protruding upwardly through the table, and adapted to work upon inner molding edges, as those of pic-

ture frames, etc. An edge-molding machine. See Fig. 3200, p. 1468, "*Mech. Dict.*"

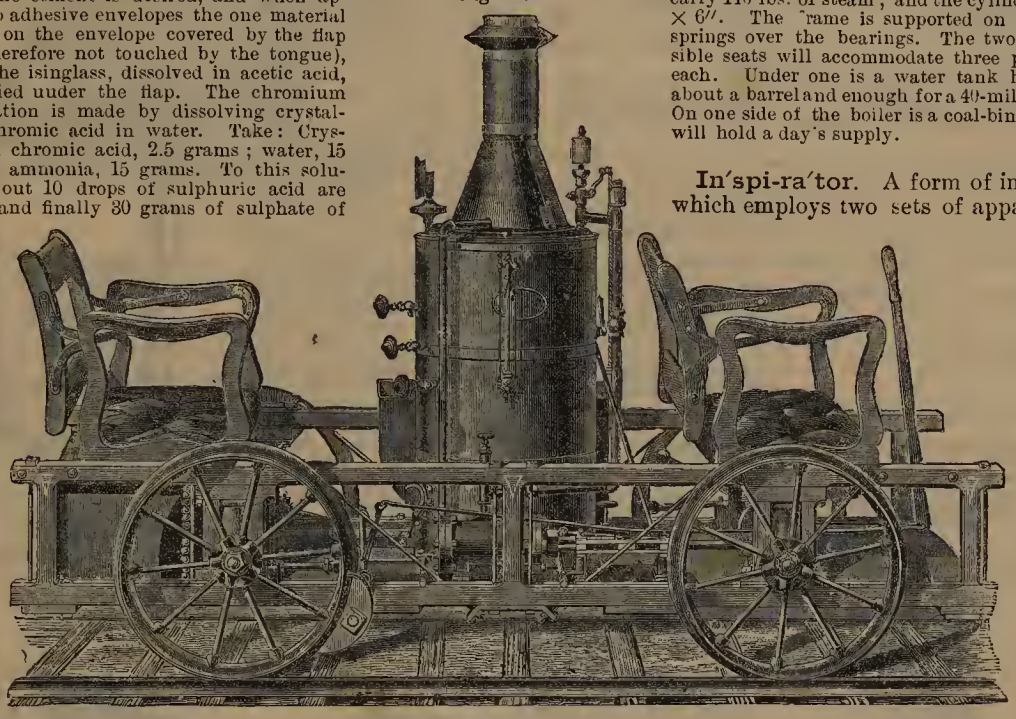
In-sol'u-ble Ce-ment'.

"A chromium preparation and isinglass forms a solid cement, which is not only insoluble in hot and cold water, but even in steam, while neither acids or alkalies have any action upon it. The chromium preparation and the isinglass or gelatine do not come into contact until the moment the cement is desired, and when applied to adhesive envelopes the one material is put on the envelope covered by the flap (and therefore not touched by the tongue), while the isinglass, dissolved in acetic acid, is applied under the flap. The chromium preparation is made by dissolving crystallized chromic acid in water. Take: Crystallized chromic acid, 2.5 grams; water, 15 grams; ammonia, 15 grams. To this solution about 10 drops of sulphuric acid are added, and finally 30 grams of sulphate of ammonia and 4 grams of fine white paper. — "*Dingler's Polytechnisches Journal.*"

In-spec'tion Car. One used by the officers of a railway while inspecting the track.

Oue made by Mr. Noble is shown in Fig. 1454. The platform extends under the axles and is within 10″ of the rails. The boiler is about 42″ × 18″, intended to carry 140 lbs. of steam; and the cylinder 3½″ × 6″. The frame is supported on rubber springs over the bearings. The two reversible seats will accommodate three persons each. Under one is a water tank holding about a barrel and enough for a 40-miles run. On one side of the boiler is a coal-bin which will hold a day's supply.

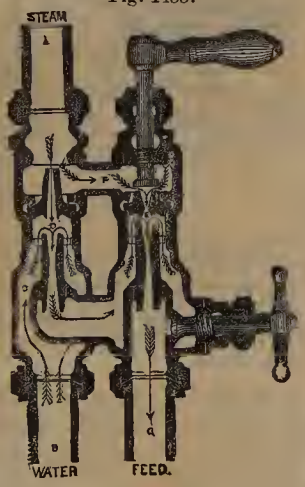
Fig. 1454.



Inspection Car.

In'spi-ra'tor. A form of injector which employs two sets of apparatus contained each in a separate chamber, but working in combination, the first of which lifts and receives the water in the pump-chambers by the suctional action of a small jet of steam, and then conducts it to the injector or forcing-tubes contained in the second chamber. The water is then transmitted to the boiler by the aid of a second jet of steam, which constitutes the forcing element, and which impinges upon the stream of water as delivered by the pump, and forces it directly into the boiler.

Fig. 1455.



Hancock's Inspirator.

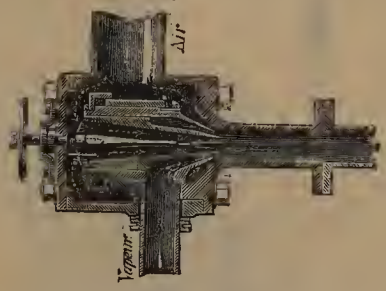
The operation is as follows: Dry steam is admitted to the instrument by opening a valve at the point *A*. The water is drawn up from the well, or other reservoir, in the chamber *B* by the creation, at that point, of a partial vacuum, and rises through the channel *C* to the point *D*, when the jet of steam drives it into *E*, as shown by the line of arrows. The forcing jet of steam is admitted through *F*, and controls the feed-current at *E*, passing to the boiler down the feed-pipe *G*.

See also INJECTOR.

Hancock . . . . * "*Iron Age*," xxv, March 4, p. 17.
* "*Scientific American*," xl. 99.
* "*Mining & Scientific Press*," xxxv. 409

In'suf-fla'tor. 1. A blower feeder for furnaces. It is on the principle of the injector. An annular blast of steam draws in and violently projects a current of air into the furnace. Siemens' insufflator is shown in Fig. 1456. In the petroleum feeders for furnaces the same device is used, concentric currents of petroleum and air being injected by a blast of steam.

Fig. 1456.



Siemens' Insufflator.

2. (*Surgical.*) A powder blower. Named according to the nature or place of application, as: *Laryngeal, Esophageal, Rectal, Oral*, etc. A syringe, in effect: may be an *atomizer* or *fumigator*.

See also AUTO-INSUFFLATOR, Fig. 131, p. 57, *supra*.
See also INJECTION SYRINGE, *i*, Fig. 2678, p. 1191, "*Mech. Dict.*"

In'su-la'ted. (*Electricity.*) Protected from contact with other conductors.

In'su-la'tor. A material of extremely small conductivity isolating a wire from the ground, or interposing between an electrified body and other objects.

A piece of wood cut from a tree is a good electrical conductor. Let it be heated and dried, it becomes an insulator. Let

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it be baked to charcoal, it becomes a conductor again. Burn it to ashes, and it becomes an insulator once more.

Addition to instances shown on p. 1191, "*Mech. Dict.*"

	* "*Scientific Am. Sup.*," 1628.
Teleg., *Bloomfield*	* "*Sc. American*," xliii. 387.
Cardeaux	* "*Telegraphic Jour.*," vi. 287.
Creighton, Br.	* "*Engineer*," xlix. 107.
Creighton	* "*Teleg. Journal*," vii. 146.
Creighton, Br.	* "*Engineering*," xxix. 120.
European	*Brooks'* "*Vienna Exp. Rep.*," 1873.
Fuller	* "*Teleg. Journal*," vi. 3.
Johnson & Phillips, Engl.	* "*Teleg. Journal*," v. 245.
Lightning-guard, *Oppenheimer*	* "*Teleg. Journal*," vii. 127.

In'te-gra'tor. Invention of J. Amsler-Laffon. The object of the instrument is to find the area, the statical moment, and the moment of inertia of any closed curve, by simply tracing out the curve with a pointer, the machine doing all the rest.

Mechanical, *Amsler-Laffon*, Fr.	* "*Engineering*," xxix. 462.
	* "*Engineer*," xlix. 252.
	* "*Sc. Amer. Sup.*," 3930.
Integrating machine.	
Sir W. Thomson	* "*Van Nost. Mag.*," xv. 301.
	* "*Engineering*," xxx. 561.

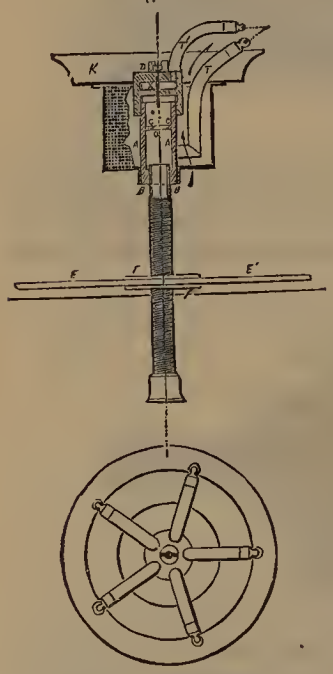
See also HARMONIC ANALYZER, page 438, *supra.*

In-ten'si-ty. (*Electricity.*) Another name for tension; capacity to overcome resistance.

In-ten'sive Gas Burn'er. (Fr. *bec Mallet*) A late French form of gas burner.

The burners, ordinary batswings, are placed in pairs on the circumference of a circle, so that their tubes of supply represent radii of the circle In the burner shown in the section and plan in Fig. 1457 there are five pairs, or ten burners. The lower ones are inclined from the horizontal in an upward direction, so that the flames join together into one. The upper row is supplied from a chamber, *X*. The disk crossing the center of the chamber may be raised or lowered by the central screw, thereby giving less or more gas to the upper circle of burners. The chamber has a hollow thread cut in it, and screws up and down on the tube *A A*, so that the distance between the two circles of burners can be regulated. The lower burners are supplied from the tube *A A*. This tube has also a hollow screw cut in it and the main supply tube *H* screws into it. By screwing the supply tube *H* into the tube *AA* the supply of gas to the lower circle of burners is cut off as the end of the tube *H* approaches the diaphragm *C C* perforated with a hole *D*, while the supply to the upper burners is obviously unaffected. Thus the supply to either circle of burners can be increased or diminished or cut off entirely; and either can be lit, to the exclusion of the other. At *L* is represented a basket in wire gauze surmounted by a plate *K*. The air that passes through this is supposed to be somewhat heated, and supplies the flame through the interior of the apparatus, and the shield preserves the flame from currents of cold exterior air.

Fig. 1457.



Bec Mallet. (*Section and Plan.*)

Fig. 1458 shows the general effect of the Mallet burner in a street lantern.

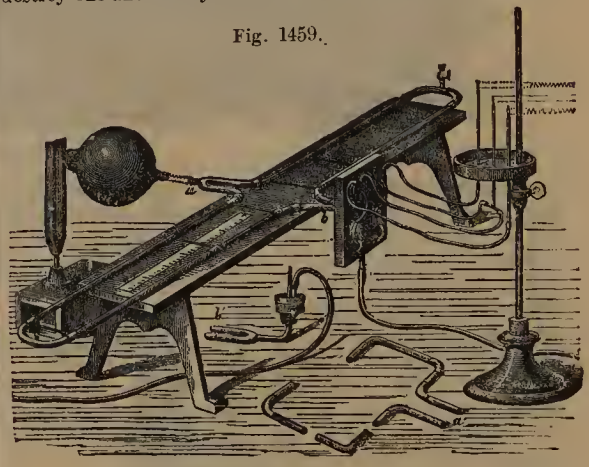
In'ter-fe'rence Ap'pa-ra'tus. An apparatus by M. Koenig for investigating the theory of sound. That shown in Fig. 1459 is for observing the interference of sonorous waves.

The apparatus consists chiefly of two U-shaped tubes, fixed horizontally upon a board, but so arranged that their length may be changed, on the same principle as the trombone with the well-known sliding piece: these allow the tubes to be made of the same length, or different according to any length desired. These tubes connect mutually by both ends; at one connection, *a*, a resonator is attached, serving to intensify the sound of a large tuning-fork, with which it is in unison, and to conduct it through both tubes to the other end *b*. When these tubes have the same length, the waves will arrive equally through both routes; but if we lengthen one of the arms until the difference between them amounts to half a wave-length of the note of the tuning-fork, the waves coming through the two conduits destroy each other at the other end of the tube, and if we allow this to terminate in a small cavity, above which is a manometric capsule, we shall see, on lengthening one of the arms, how the deeply cloven flames in the revolving mirror are gradually changed into bands of light when the difference of half a wave-length is reached, corresponding with the point where the two waves destroy one another by interference.

Fig. 1458.

Intensive Gas-burner.

Fig. 1459.



Koenig's Interference Apparatus.

See "*Manufacturer and Builder*," * viii. 12, and * v. 13, Fig. 8, also numbers for January and July, 1874, in regard to the application of resonators and mirrors in investigating the properties of sound.

See also CURVE INSTRUMENT; ELECTRICAL DIAPASON; FLAME MANOMETER; HARMOGRAPH, *supra;* and PENDULUM INSTRUMENT, *infra.*

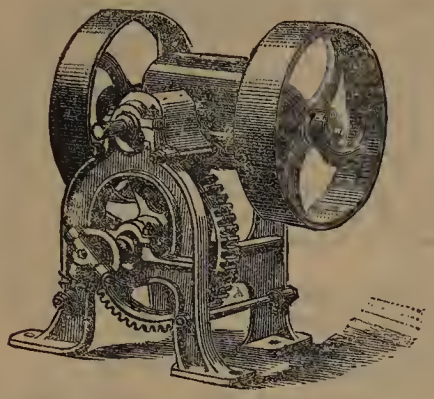
In'ter-me'di-ate Floor. (*Railway.*) A floor consisting of boards placed between the sills and floor-timbers of passenger cars and between the deafening or under floor and the upper or main floor. The purpose of the intermediate floor is to exclude noise and stiffen the floor-timbers. — *Forney.*

In'ter-me'di-ate Mo'tion. A device placed between a horse-power and a machine to be driven, to convert the motion of the tumbling-rod of the former into a band motion for the latter.

The tumbling-rod is coupled to the gimbal shown on the left, and the motion is communicated by master wheel, pinion and bevel wheels (in the case) to the band pulleys The latter are two in number, to serve separate machines

Also known as a *jack;* a jack serving 3 machines is shown at *E*, Fig. 2569, p. 1126, "*Mech. Dict.*"

Fig. 1460.



Intermediate Motion.

In'ter-me'di-ate Spin'ning Frame. In the series of spinning frames, consisting of *slubbing*, *intermediate*, *roving*, and *fine roving* frames.

In-ter'nal Gage. A gage for testing internal sizes; holes and other spaces. An internal diameter gage.

The *cylindrical* gage is a favorite form; see Fig. 772 (plain), p. 244, *supra*.
Also Fig. 994 (threaded), p. 302, *Ibid*.

In-ter'nal Pres'sure Gage. Lieut. Metcalfe's internal pressure gage, for testing pressures in exploding ordnance, is described and illustrated in the "*Report of the Chief of Ordnance*," 1877, * 361, and Plate accompanying Appendix I, *a*. It uses a conical point, and the determination of the pressure is by measuring the surface diameter of its penetration into a copper disk.

In the same volume, p. 374 *et seq.*, and Plates I.-IV., is a description of Lieut.-Col. Benton's dynamometer, used for the same purpose. Also of Rodman's internal pressure gage, p. 387, and Plate V; the Adams circular cutter, p. 388, and Plate VI.; the national armory circular cutters, p. 389, and Plates VII. to X.
See Dynamometer.
See also Piezometer, *infra*; and Crusher Gage, p. 233; Cutter, p. 239, *supra*.

In-ter'nal Screw Gage. A steel external-thread screw made to an accurate size, for measuring internal-threaded screws.

See External and Internal Gages, Figs. 993, 994, p. 322, *supra*.

In'ter-os'se-ous Saw. (*Surgical.*) A fine thin saw for working between bones, as those of the fore-arm, the lower leg, the ribs. — *Lente*.

In'ter-rupt'ed Cur'rent. (*Electricity.*) An intermittent current caused by the rapid action of a rheotome or vibrating armature. The primary and secondary currents are generally interrupted ones, and the galvanic or battery current can also be, if required.

In'ter-rupt'er. (*Electrical.*) An automatic apparatus, used in connection with the chronograph and wire-targets, to ascertain the velocity of flight of projectiles.

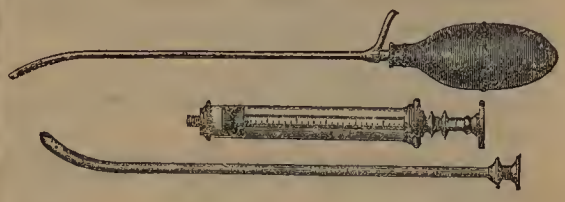
The *Russell* interrupter, used in connection with the *Schultz* chronoscope, is described on pp. 42, 45, and Plate I, "*Ordnance Report*," 1878.

In'tra-u'te-rine Syr'inge. (*Surgical.*) An instrument for injecting the uterine cavity.

The upper one in Fig. 1461 is *Molesworth's*. It consists of an elastic bulb and double canula; the fluid is discharged directly forward, towards the symphysis pubis, without danger of throwing the jet into the Fallopian tubes, and escapes as fast as thrown in, or may be retained as long as desired, and all withdrawn by relaxing the pressure on the bulb; the tube is silver, and the curve easily changed.

The lower one in the figure is *Gautillon's*. It has also the reverse flow, a graduated glass barrel, and a silver tube.
Intra-uterine and uterine electrodes, for introduction through the cervix and for clasping the neck of the uterus respectively, are shown in *Tiemann*, Part I. page 106.

Fig. 1461.



Intra-uterine Syringe.

In-trench'ing Spade. One carried by troops for making earthworks.

See Burgoyne, Fig. 77, p. 147, *supra*.
Harrison's, Fig. 2691, p. 1193, "*Mech. Dict.*"
Rice's Trowel Bayonet, Fig. 6673, p. 263, "*Mech. Dict.*"
The Austrian intrenching spade has a jointed handle.
See also intrenching tool, *Buskett*, * "*Scientific American*," xl. 202.

In-ver'sion Bat'te-ry. (*Electricity.*) One in which the inversion, or upsetting of the battery, throws the exciting liquid against the plate or plates and sets the battery in action.

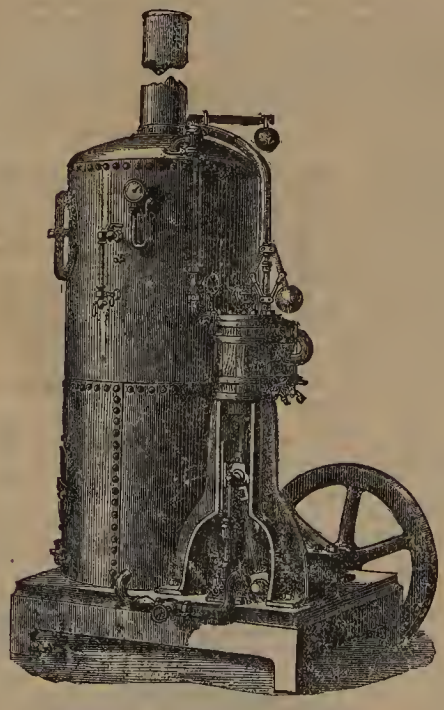
See that of M. Trouvé in connection with his electro-medical apparatus, * "*Telegraphic Journal*," vi. 475.
* "*Niaudet*," American translation, 147.

In-vert'ed Arch Bar. A wrought-iron bar bent into somewhat the form of an inverted arch, and which forms the tension member of a truss of an iron side-frame of a truck. The ends of an inverted arch-bar rest on the journal-boxes, and the arch-bar is on top of it. — *Forney*.

In-vert'ed Steam En'gine. A form of steam-engine useful in yachts and launches, as it allows direct connection to a propeller-shaft which has its bearings on the base-plate.

Several forms are shown in Figs. 2695, 2696, p. 1194, "*Mech. Dict.*" See also *Craig*, Br. * "*Engineer*," i. 3.

Fig. 1462.



Inverted Steam Engine.

In'wall. The lining wall of a smelting furnace; specifically, that part of it which is above the boshes.

I'on. (*Electricity.*) A product of voltaic decomposition.

Ir'i-dec'to-my In'stru-ments. (*Surgical.*) Instruments for operating upon the *iris* of the eye. See IRIDECTOME, p. 1195, "*Mech. Dict.*"

Iridectomy instruments include those for artificial pupil, dislocating the natural pupil, and incision. See KERATOME, p. 1223, "*Mech. Dict.*"

PUPIL, ARTIFICIAL, p. 1835, *Ibid.*

See also for knives, scissors, needles, forceps, sharp and blunt hooks, p. 30, Part II., *Tiemann's* "*Armamentarium Chirurgicum.*"

Ir'i-dec'to-my Scis'sors. (*Surgical.*) For operating upon the iris. See *Althof's, d* Fig. 4672, p. 2054, "*Mech. Dict.*"

I-rid'i-a'ted Glass. Glass, the surface of which has acquired opalescence or the iridescence familiar in mother-of-pearl, by exposure for a long period in the ground, or by artificial means for producing the same effect. See IRIDESCENT GLASS.

Iridescent lace, *Helouis*, Fr. . "*Sc. American,*" xxxix. 134.

Ir'i-des'cent Glass. The cause of the change in the structure of the ancient glass, — the articles exhumed by General di Cesnola, at Idalium and Golgoi, in Cyprus, being the most brilliant specimens (see p. 973, "*Mech. Dict.*"), — is understood to be the combination of the alkaline components of the glass with carbonic acid, setting free the silicic acid. The alkaline carbonate, being washed away, leaves the surface in a laminated condition, adapted to refract light from a multitude of surfaces, giving the same appearance as the wavy structure of *nacre* or mother-of-pearl. It is said that analysis of some of the di Cesnola glass proves the fact of the changed chemical condition stated.

Specimens from China and Burmah indicate that means are in the possession of these Orientals for producing the rainbow tints, and Clémandot and Frémy have succeeded in producing the irideseence by placing the glass under a pressure of 2 or 3 atmospheres for 6 or 7 hours in a water-bath containing 15 per cent. of hydrochloric acid at a temperature of 248° Fah.

The wondrous beauty of the Cyprian specimens directed special attention to the subject, but it had long been noticed that Etruscan and Roman glass had acquired this property, and specimens in the European museums, in Italy especially, had made the appearance familiar. That the still more ancient glass of Egypt had not manifested the same peculiarity is accounted for by the dryness of the atmosphere of that country, although some Egyptian glass is not destitute of iridescence.

The process of Webb & Son, of England, is as follows: —

Chloride of tin or tin salt is burnt in a furnace, and the hot glass, while on the ponty in the last stage of the course of manufacture, is exposed to the fumes. To give greater depth to the tints, nitrates of bromine and strontium are used in small quantities.

Investigations of the Austrian and Bohemian irideseent glass show that the proeess there pursued is by heating the glass and causing the deposit of a metallic oxide on its surface by reduction. Bismuth is used, and M. Peligot has detected it by analysis.

Bohemian (lime glass) glass is thought to be the most suitable for this treatment.

Producing colors on glass by fuming vapors, forms the subject of a U. S. Patent to F. S. Shirley, Dec. 18, 1877. It is, however, a European invention, and was shown by Lobméyr, the pioneer in this line, in the Austrian section, at Philadelphia, in 1876.

Articles made with a beautiful iridescent surface are now common in shop windows; globes of this character having their effect enhanced by filling with water. It is perhaps more effective in partial shadow than in full light. Chandeliers and decorative bulbous plates of this kind of glass are extremely brilliant. Black beads, for trimmings of ladies' costumes, are now made as iridescent as peacock coal.

Clémandot's patented process produces beautiful effects. The main feature of the process is the application of acids to the glass, under a pressure of from two to five or more atmospheres. Water containing 15 per cent. of hydrochloric acid is used to bring out rainbow tints like mother-of-pearl; and artificial gems of various sorts have thus been manufactured. The glass prepared by these processes is quite as iridescent as that which antiquaries so much value, the pressure and the acids hastening a result that the ordinary agencies of the atmosphere would take centuries to produce.

To remove the tendency of window glass to show iridescent colors, it may be plunged as it is taken from the *leer* into a bath of water, with 2% of hydrochloric acid.

"*Iron Age*"	xxii., July 4, p. 20; xxvi., Aug. 26, p. 15.
"*Eng. & Mining Journal*" .	xxv. 99; xxvii. 44.
"*Mining & Scientific Press*"	xxxviii. 402.
"*Scientific American*" . . .	xliii. 198; xxxvi. 211; xxxviii. 23, 134; xxix. 6, 368; *Clémandot*, xliii., 198.
"*Am. Manuf. & Iron World*"	xxiv., Jan 3, p. 11.
"*Telegraphic Journal*" . .	*Clémandot*," vi. 67.
"*Engineer*"	xlv. 45.
"*Scientific American Sup.*" .	* 1382, 1800.
"*English Mechanic*" . . .	xxvi. 172.

I'ris-a'ted Wire, etc. An invention of Nobile, improved by Becquerel and M. Hélouis, of France, in which metallic threads, lace, and ribbons are *irisated* by means of binoxide of lead, producing delicate fibers of binoxide in concentric rings, with varied colors, like those of soap bubbles.

Nobile used electro-chemical means. Becquerel devoted time to its elucidation, and substituted a solution of oxide of lead in potassa or soda.

M. Hélouis has succeeded in irisating ribbons, threads, and bands, objects in some cases of such tenuity as to have a length of 32,800 feet to the pound.

I'ris-a'tion. Conferring the tints of nacre.

To produce rainbow tints on metals: Dissolve 3 parts hyposulphite of soda in 30 of water and mix in 1 of sugar of lead. The mixture is precipitated on being heated to 70° or 80° Réaumur, depositing sulphuret of lead. In the presence of any metal this deposit is made upon it. According to the thickness of the deposited layer various iridescent colors appear on the surface of the metal. To produce this coloration uniformly the object should be heated throughout.

Hélouis	"*Technologiste*," xli. 444.
Of glass	"*Technologiste*," xxxviii. 373.
Frémy & Clémandot .	"*Technologiste*," xl. 68, 117.
Paper by *Lockert* . .	"*Scientific American Sup.*," 1382.

I'ron. The history and divisions of the subject are given on pp. 1195–1206, "*Mech. Dict.*" See also lists under FURNACE, p. 926, *Ibid.*; and METALLURGY, pp. 1424, 1425, *Ibid.*

See also references: —

Art work	"*Iron Age*," xvii., May 11, p. 13.
Assaying, *Bruno Kerl* .	* "*Scientific Amer. Sup.*," 252, 340.
Bridge, *Kuilenberg*, Holl.	* "*Scientific American*," xlii. 387.
Building	"*Van Nostrand's Mag.*," xvi. 470.
"*Building News*" .	"*Iron Age*," May 3, p. 7; May 10, p. 3.
	"*Scientific American Sup.*," 1123.
Cutter, "Old Colony" .	* "*Iron Age*," xix., Feb. 1, p. 1.
Fence pickets	* "*Iron Age*," May 3, p. 11.
Fortificatious.	
Sheerness, Br. . . .	"*Iron Age*," xix., Mar. 29, p. 23.
House, Manchester, Br.	"*Scientific American Sup.*," 1969.
Ingot press, *Jones*, Br. .	* "*Engineer*," 1. 101.
Inlaying with pearl . .	"*Iron Age*," xxv., Feb. 12, p. 5.
Japanese	"*Scientific American*," xxxiv. 358.
Microscopical exm. . .	* "*Scientific American Sup.*," 2620.
Nail works, Sable.	
Zuy & Co.	* "*Iron Age*," xix., April 5, p. 1.
Pavement, Paris . . .	"*Scientific American*," xxxiv. 242.
Ships, American . . .	"*Scientific American*," xxxvi. 273.
Steel and iron, *Siemens*	"*Scientific Am. Sup.*," 1112, 1121.
Holley & Smith . . .	"*Scientific American Sup.*," 1184.
Steel and iron, advances,	
Akerman, Switz. . .	"*Van Nostrand's Mag.*," xix. 459.
Work, ornamental . .	"*Iron Age*," xix., May 10, p. 1.
Works, Creusôt plan .	* "*Engineering*," xxvi. 275.

I'ron A-mal'gam. Sideraphthite: composed of 65 parts iron, 23 nickel, 4 tungsten, 5 aluminum, 5 copper.

It resists sulphureted hydrogen, is not attacked by vegetable acids, and only slightly by mineral acids. It is useful as a substitute for standard silver, while it can be produced at a cost not exceeding that of German silver. For alloys which have to be silver-plated to prevent oxidation, the inoxidizable iron, as the above is called, is stated to be a successful substitute.

Ir'on Bar'row. A wrought-iron wheel barrow for moving iron in pig, sheets, or bars.

I'ron Ce-ment'.

Dried and powdered brick earth	4
Peroxide manganese	1
Fine iron filings (free from rust)	2
Common salt	0.5
Borax	0.5

Mix, grind, and make into a paste with water. Apply when freshly made. Warm, and then expose to a nearly white heat.

Another: Sifted peroxide of manganese 1
Triturated zinc 1

Ruh up into a pasty condition with common water glass. Apply while freshly made.

See also recipes, p. 182, *supra;* and pp. 507-509, "*Mech. Dict.*"

I'ron Clad. The Italian iron-clads are at present the most formidable.

"The new twin-screw double-turret vessel 'Dandolo,' belonging to the Royal Italian navy, excepting in the omission of the internal torpedo deck, resembles the sister ship 'Duilio' in her general arrangement, but has considerably surpassed her in speed. The 'Dandolo' was built at the royal naval arsenal at Spezzia, under the supervision of Director Borghi, at whose suggestion the whole of the bow plating is worked flush, instead of the plates overlapping as usual. The length of the vessel is 337′ 8″, the breadth 62′ 3½″; the mean draft at the trials with armament on board was 28′ 9″, giving a total displacement of 11,225 tons. The battery is heavily armored, and is placed in the middle of the vessel; the two turrets rise above the weather-deck, and are placed diagonally in the battery, so as to enable all four guns to be fired fore and aft. The armor of the turrets is impenetrable to all except the heaviest modern artillery. Each turret contains two 100-ton Armstrong guns, made at Elswick, having a bore 17.72″, throwing a shot 2,018 pounds, with a maximum of 511 pounds of powder, the ordinary charge being 355 pounds. The turrets and guns are moved and worked by a complete system of hydraulic gear, made at Elswick. The loading is also done by the same means, the rammers being below the weather-deck, and arranged to enter the gun when the muzzles are depressed for the purpose. Between the turrets is situated the mast, which really assumes the function of a look-out tower, as there are no sails.

"The 'Dandolo' carries four large steam launches and eight other boats, all hung upon hinged davits which are worked from the steam capstan, and which will hoist them right on board. The 'Dandool' is propelled by twin screws worked by two independent pairs of engines, which were contracted for to indicate a maximum power of 7,500 horses. These engines, together with the pumping and blowing engines, were constructed by Messrs. Maudslay Sons & Field, of London. Each set of engines is placed in a separate watertight compartment, one at each side of the vessel; instead of being side by side, they are situated one in advance of the other, the alternate spaces being occupied by the magazines, which are placed immediately below the turrets. Each pair of engines has one high-pressure cylinder, 64″ in diameter, and one low-pressure, 120″ in diameter, with a stroke of 4′. Steam of 65 pounds pressure is supplied by 8 large oval and double-ended boilers, having 32 furnaces in all. Four boilers are placed forward of the engines, and the other 4 aft; but each pair of boilers is contained in a separate watertight compartment. The chimneys, which are ample in size and height, are built of 1″ plate from the main deck to the flying deck above the turrets, so as to enable them to withstand the great shock produced by the discharge of the guns.

"The 'Dandolo' ran to Genoa and back without stopping, in 6 hours and 28 minutes, with a mean indicated horse-power of nearly 7,200, and a maximum of 7,415 horses, and the speed obtained was 15½ knots, with a consumption of 51¼ tons of coal. On the measured knot trial a speed of 15.55 knots was obtained with 8,050 horse-power. No steam blast was used on any of the trials. The engines worked with perfect regularity throughout, giving a maximum number of revolutions of 74 per minute, the pitch of the screw being 23′ 6″." — *London "Times."*

See the following references: —

"Abyssinia," Br.	* *Barnard & Wright's "Rept. U. S. Engineers,"* 1871.
"Alexandra"	* "*Scientific Am.,*" xxxvi. 258, 261. "*Iron Age,*" xix., March 8, p. 1.
Australian, "Cerberus"	* "*Scientific American,*" xxxiv. 143.
Austrian	* "*Engineer,*" xli. 243. * "*Scientific American Sup.,*" 379.
"Cerberus," Br.	* *Barnard & Wright, "U. S. Engineer's Report,"* 1871.
Circular, Russian	"*Iron Age,*" xvii., March 23, p. 7. "*Engineering,*" xxi. 112, 284, 299,
Circular, Russian	"*Scientific American Sup.,*" 1487.
Cyclads	page 241 *supra.* * "*Engineer,*" xli. 75, 93, 244.
"Devastation"	* *Barnard & Wright's "Rept. U. S. Engineers,"* 1871.
"Dreadnaught," Br.	* "*Scientific Am. Sup.,*" 959, 2012.
"Duilio," Italian	"*Engineer,*" xli. 359. * "*Engineer,*" xlvi. 78. "*Iron Age,*" xvii., June 1, p. 1. * "*Engineer,*" xliii. 162. "*Van Nostrand's Mag.,*" xxii. 437. * "*Scientific American,*" xxxvi. 57.
"Foo-so," Japanese	* "*Engineering,*" xxiv. 371.
"Hamidieh," Turkish	* "*Scientific American,*" xxxvi. 370.
"Huascar," Peru	* "*Engineering,*" xxviii. 455.
"Huascar," after conflict	* "*Engineer,*" xlviii. 439.
"Independencia," Braz.	* "*Scientific American Sup.,*" 1861. * "*Engineering,*" xxv. 107, 110.
"Inflexible," Br.	* "*Engineer,*" xlv. 195. "*Iron Age,*" xvii., June 1, p. 1. "*Scientific American Sup.,*" 1936.
"Italia"	* "*Scientific American Sup.,*" 4089.
"Li-Ki," Japanese	"*Scientific American,*" xxxix. 5.
"Magdala,"	* *Barnard & Wright's "Rept. U. S. Engineers,"* 1871.
"Memdouhiye," Turkish	* "*Engineer,*" xliii. 65.
Monitor, the first, *Welles*	"*Iron Age,*" xix., April 12, p. 3.
Navies of the world. Table	"*Iron Age,*" xix., June 28, p. 14.
"Nelson," Br.	* "*Engineering,*" xxii. 434. "*Scientific American Sup.,*" 804.
"Novgorod," engines of	* "*Engineering,*" xxi. 275.
"Payki Shereef," Turk.	* "*Scientific Amer.,*" xxxviii. 119.
Peruvian	* "*Engineering,*" xxviii. 12.
"Polyphemus," Br.	"*Iron Age,*" xxiv., Aug. 28, p. 3. "*Scientific American,*" xli. 306.
"Redoubtable," Fr.	"*Scientific American Sup.,*" 660.
Swedish gunboat	* *Barnard & Wright's "Rept. U. S. Engineers,"* 1871, Plate XXIII., p. 120.
"Téméraire"	"*Engineer,*" xli. 359.
"Thunderer,"	* *Barnard & Wright's "Rept. U. S. Engineers,"* 1871.
"Vanguard," sunken	"*Scientific American Sup.,*" 1088.
"Vasco de Gama," Port.	"*Engineering,*" xxii. 17. "*Scientific American Sup.,*" 570.

See ARMOR PLATING, Figs. 337-358, and Plate IV., "*Mech. Dict.,*" pp. 150–155; also ARMOR PLATE, p. 47, *supra.*

See also comparison of iron clads, Fig. 2703, p. 1202, "*Mech. Dict.;*" also *Clark's* U. S. Patents, No. 231,899.

I'ron Cut'ter. 1. A machine for cutting iron in bar or sheet. See SHEARS, Figs. 4929–4934, pp. 2136, 2137, "*Mech. Dict.*"

2. A circular saw for cutting hot iron.

A number of the supporting brackets are fitted on a rod, 3′ to 4′ long, so arranged as to be set up in the position shown, or dropped down out of the way, as the length of the iron being cut may require. Adjustable gages for determining the length of the pieces cut are provided on the opposite side of the machine from the one shown in the engra-

Fig. 1463.

Iron Cutter.

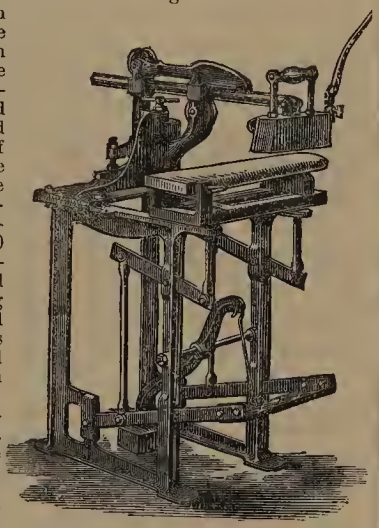
ving. The belt coming down from a shaft above becomes slightly tightened as the saw is pressed forward to the iron, and loosened again when the saw returns to the position shown. The purpose of this arrangement is to avoid unnecessary strain upon the saw spindle when the machine is not in use, and to permit it to run continuously, a matter of convenience when a number of workmen use the same machine, as it saves stopping and starting each time a piece is to be cut. — *Richards.*

See also IRON SAW.

I'ron-ing Ma-chine'. A machine for pressing clothes, fabrics, or hats, to smooth and polish the surface.

Sanson's machine, Fig. 1464, is a pressing machine for tailors' use. By means of the swivel frame moving on friction roller, the iron can be moved in any direction. The lifting and depressing is parallel and evenly distributed over the surface of the board. The pressure is by treadle which is counterbalanced, and is adjustable up to 1,000 pounds. The machine has wide and narrow pressing boards, for optional use. The iron is moved by hand, and heated by gas from a flexible tube.

Fig. 1464.



Sanson's Pressing Machine.

Thurston's polishing machine for a laundry obtains the pressure by a spiral spring communicating with the iron by means of universal joints and levers. The table is stationary, and the pressure of the iron can be regulated by a lever to suit the work.

Walker's machine for tailors' use has an iron swiveled at the end of a double-jointed arm, free to turn about a vertical shaft, and raised or lowered by a spring and foot-lever. The iron is moved by hand and has an inserted iron heater.

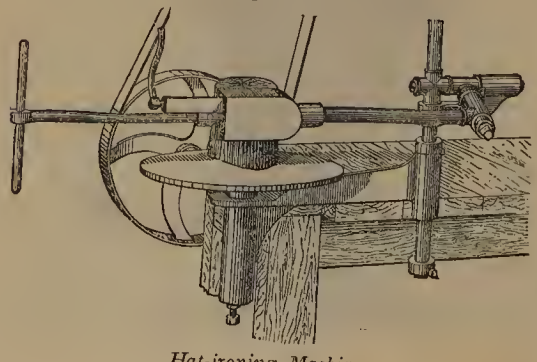
In the *Storrs* presser, the goose may be turned in any direction at the end of an arm, connected by a pivoted link with the upper end of a ⊃-shaped arm supported on a horizontal bearing. The pressure is by a foot-lever; the iron is heated by an inserted hot plate and is moved by hand.

In *Leopold's* ironing and polishing machine the article is laid upon a horizontally reciprocating and automatically reversible board. The iron is heated by steam, and has a short, rapid reciprocating movement by means of a short vertical shaft, rotated from a horizontal shaft held in an arm adapted to be vibrated horizontally. The iron support has a ball-joint and a handle which is grasped by the operator, and is moved over the material on the bed while being reciprocated mechanically.

Tyler's machine has a small polishing iron with a concavity in its upper surface, and is pressed down on the material by means of an adjustable spring on a hinged arm, pivoted at the outer end of a swinging frame. The table is adjustable.

Fig. 1465 is *Osterheld & Eickemeyer's* machine for ironing the sides, crowns, and tips of wool hats. An iron frame is

Fig. 1465

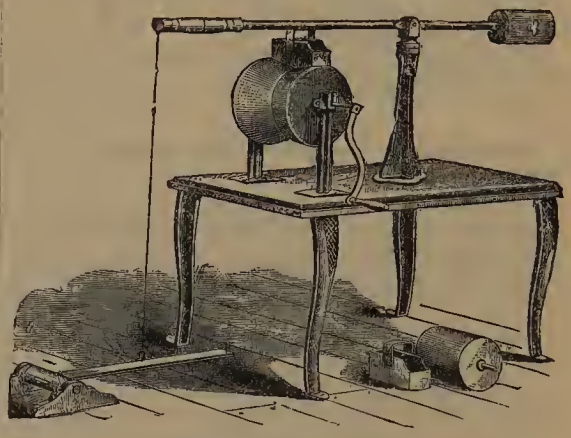


Hat-ironing Machine.

secured on the edge of the finishing-bench; on it is a revolving table which supports the block on which the hat is drawn. The iron is heated by a Bunsen gas-burner fed by a flexible tube, and the lever which connects the iron with the joint is a wrought-iron pipe, and serves as a leader to the upright pipe and forms a chimney which produces sufficient draft to carry off all the gases and prevent the formation of soot and the soiling of the hats.

Fig. 1466 is a block ironing machine. The iron is of a

Fig. 1466.



Block Ironing Machine.

shape to suit the object which is blocked, and the object is rotated beneath the counterbalanced lever which carries the iron. The pressure is by means of a treadle.

I'ron-ing Stove. A stove specially adapted for heating smoothing irons.

Fig. 1467 is a French *fourneau à repasser*, a cast-iron stove, adapted for 7 irons.

Fig. 1467.

French Ironing Stove.

I'ron-ing Ta'ble. A table specially adapted for use in ironing clothes.

Gilbert's table is capable of being folded, and when extended, affords a long board for use in ironing dresses, shirts, and trousers, which may be conveniently slipped on to it. (See Fig. 1468.)

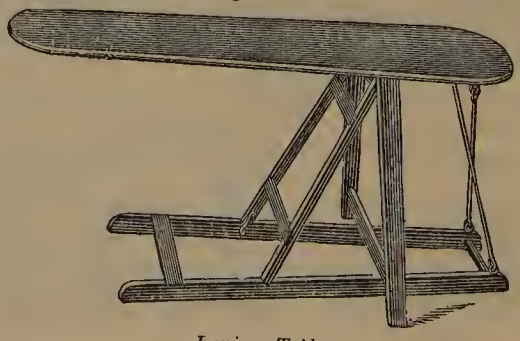
Fig. 1469 shows a French steam-heated table for pressing pantaloons or coats. It is a hollow iron arm projecting from the wall, and having the necessary pipe connections for steam and condensed water respectively. See also LAUNDRY.

Hogin . * "*Sc. Amer.*," xl. 194.

I'ron Pla'ting.

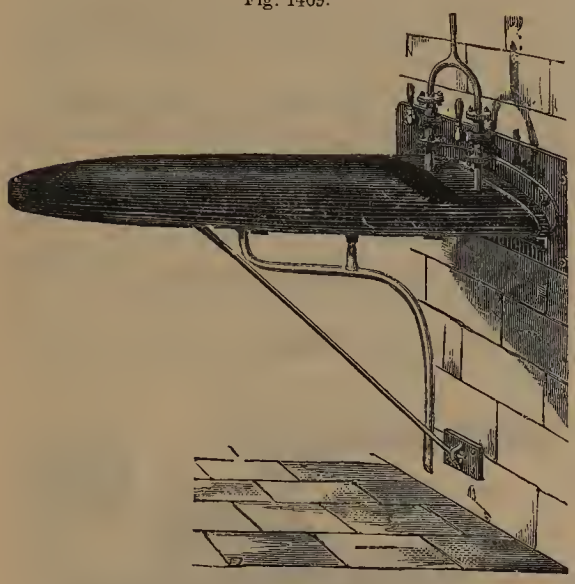
For coating copper plates with iron: Ten parts of ferrocyanide of potassium and 20 parts of tartrate of soda are dissolved in 220 parts of distilled water, adding a solution of three parts of sulphate of iron in 50 parts of water. Caustic soda soln-

Fig. 1468.



Ironing Table.

Fig. 1469.



French Steam Table for Pressing Coats and Trowsers.

tion is poured into the mixture until the Prussian blue formed is redissolved — *Prof. Bottger.*

I'ron Pre-serv'ing Pro'cess. Barff's process consists in subjecting the surface of the iron to the action of super-heated steam at a high temperature. The result is the production upon the surface of the iron of a hard, smooth, and durable skin of black oxide of iron, which prevents rust, and is claimed to be more effective than any paint, lacquer, rubber, or other compound or process heretofore known.

Iron articles to be treated by this new process are first cleaned with dilute sulphuric acid, and afterward with bran water They are then placed within a muffle, the temperature of which is 500° or 600° Fah.; dry superheated steam at a temperature of 1,000° Fah. is admitted, atmospheric air being carefully excluded. The formation of the black oxide skin rapidly takes place.

I'ron Pro'cess. Siemens' direct process briefly stated —

"Consists in smelting successive charges of ore in a rotary puddling furnace. A charge of about 20 cwt. of crushed ore mixed with the proper fluxing material is placed in the rotating puddler. When, by the flame from a regenerative furnace, it has been brought to a red heat, from 500 to 600 pounds of small coal is added and the speed of the puddler is increased. The reduction of the ore to the metallic state proceeds rapidly, the carbonic oxide evolved is burned within the chamber, and very little gas from the gas-producers is required. When the reduction is complete the puddler is stopped, and the fluid slag is drawn off. The puddler is then rotated rapidly; the iron is collected into two or three metallic balls, which are withdrawn and treated in the usual way. About two hours are required for a charge, and assuming that 1,000 pounds of iron are got out to each charge, the furnace would produce about 5 tons of puddled bar per diem. It is claimed to be feasible to push the operation so far within the rotator as to produce cast-steel. Mr. Siemens claims and undertakes to demonstrate that by this process a very great saving of fuel is effected. For the lining of the rotary puddler, after numerous trials, he has found a mixture of calcined bauxite powder with clay and graphite to be the best. Three per cent. of clay and six per cent. of graphite give the best results as binding materials. Bauxite is a ferruginous clay, containing from one to four per cent. of silica. The graphite, under the intense heat, reduces the oxide of iron in the bauxite to the metallic state. Linings so made have been found to be very durable, far more so than the best fire-brick." — *Blake.*

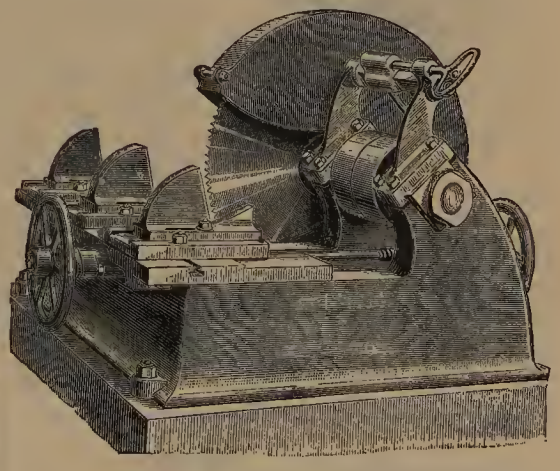
See also,—

Protection, *Barff* . . . * "*Engineering*," xxviii. 441.
Bower, Barff . . . "*Scientific American Sup.*," 2001.
Barff . . . . . "*Manufacturer & Builder*," x. 54.
"*Min. & Sc. Press*," xxxviii. 315.
Process, *Bell* . . . . "*Scientific American Sup.*," 517.
"*Van Nostrand's Mag.*," xvi. 281.
Processes and products,
Ou, *Bessemer* . . . "*Van Nostrand's Mag.*," xvii. 75.
Furnace, *Bicheroux* . . * "*Eng. & Min. Jour.*," xxi. 55.
Process, sponge, *Blair* . "*Scientific American*," xxxix. 68.
"*Scientific American Sup.*," 1992.
"*Scientific American Sup.*," 1991.
Direct, Brady's Bend, Pa. . . . . "*Van Nostrand's Mag.*," xxi. 260.
"*Iron Age*," xxii., Sept. 26, p. 14.
Casson-Bicheroux . . * "*Iron Age*," xxv., May 6, p. 1.
Du Puy . . . . . "*Engineering*," xxv. 54.
"*Scientific American Sup.*," 2495.
"*Iron Age*," xxii, Oct. 3, p. 5.
Preserving, *Dodé* . . . "*Scientific American*," xl. 320.
Works, Domnerfoet, Swe. "*Iron Age*," xxv., Feb. 19, p. 1.
Process, *Ellerhausen* . . "*Iron Age*," xxiii., Feb. 13, p. 15.
Gilchrist . . . . . "*Iron Age*," xxiv., July 3, p. 11.
Henderson . . . . "*Iron Age*," xviii., Sept. 7, p. 18.
Jacobi, Bohemia . . "*Iron Age*," xvii., March 2, p. 1.
Knowles . . . . . "*Scientific American Sup.*," 58.
Krupp . . . . . "*Scientific American Sup.*," 2777.
Furnace, *Lyttle* . . . * "*Scientific American Sup.*," 378.
Process, *Peckham* . . "*Iron Age*," xxiii., March 27, p. 7.
Furnace, *Ponsard* . . * "*Engineering*," xxv. 450.
* Figs. 1161, 1162, p. 387, *supra*, and references *passim.*
Process, direct, *Reese* . "*Scientific American Sup.*," 869.
Furnaces, Salisbury . . * "*Railroad Gazette*," xxi. 506.
Furnace, direct process. "*Iron Age*," xx., Sept. 6, p. 7.
Siemens . . . . . "*Vienna Rept.*," IV., § E, p. 232.
Furnace, *Siemens* . . Figs. 1159, 1160, p. 386, *supra*, and references *passim.*
Standard Co., Engl. . . "*Scientific American Sup.*," 589.
Thomas & Gilchrist . . "*Iron Age*," xxv., May 6, p. 1.
Iron and steel process.
Willans, Engl. . . . "*Scientific American*," xxxvii. 1.
Iron and steel. Résumé of processes, *Williams* "*Scientific American Sup.*," 2875.
"*Sc. American*," xxxvii. 394.
"*Practical Magazine*," iv. 404–408.

Julien, A., Patent 163,080, July 18, 1874.
Cook, A. F., Patent 166,454, August 10, 1875.
Bennett, J. F., Patent 161,320.

I'ron Saw. Massey's circular saw for hot iron is 30″ diameter, is fixed upon a steel shaft, and runs 1400 revolutions per minute. It is securely cased in to prevent accidents, and the table which carries the bar to be cut is moved by a quick-threaded screw actuated either from the front or back of the machine. See also IRON CUTTER.

Fig. 1470.



Circular Saw for Hot Iron.

I'ron Scale. A special heavy weighing scales with a bed of iron bars, used in weighing merchant iron, pig or castings.

I'ron Shears. Cutters, either hand or machine, for iron. See SHEARS, Figs. 4929–4934, pp. 2136, 2137, "*Mech. Dict.*"

See also IRON CUTTER; IRON SAW, *supra.*
Brown & Curtiss . * "*Iron Age*," xix., June 21, p. 1.

I'ron Steel. Metal composed partly of steel and partly of iron. In the process of manufacture a thin sheet of iron is introduced between the surfaces to be united.

A mold for casting is divided into two compartments by a transverse metal plate, and the two metals previously refined are poured each into its compartment. The iron plate serves at the same time to prevent their mixing and to facilitate their union by becoming partly fused. — *Asbeck, Osthaus & Eicken*, Hagen, Westphalia.

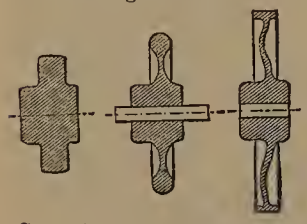
I'ron Strapped Block. (*Nautical.*) One having a loop or band of iron, as contradistinguished from the rope band or strap, formerly exclusively and yet much employed.

I'ron-stone China. (*Ceramics.*) A variety of stone-ware.

I'ron Wheel. Iron wheels are customary with railway and street cars, some kinds of agricultural implements, parts of machines, etc. They are usually cast, composite wrought and cast, and more seldom all of wrought iron.

A plan for rolling wrought-iron wheels in a single piece has been invented in Belgium.

Fig. 1471.



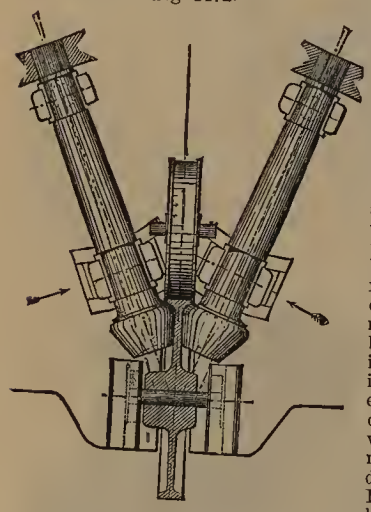
Successive Stages of Wrought Wheel.

The iron first receives the shape shown at the left hand, in Fig. 1471.

Secondly that of the wheel to the right of it. Up to this point it may be an ordinary compression forging. A hole is then bored and a rod fitted in.

The right hand one of the three exhibits a section of the finished wheel. The machine by which the last transformation is made, is shown in Fig. 1472.

Fig. 1472.



Wheel-making Rolls.

It consists of two conical rolls, each mounted on a separate shaft, which is rotated by means of conical gearing, and which is placed in such bearings that the conical rolls at their extremity can be approached by moving them, as indicated by the arrows. The wheel to be finished rests with its axle in two bearings, and it is then exposed to the action of the conical rolls, which compress the material so that its diameter increases. In order to make allowauce for this, the position of the bearings of the wheel are adjustable. The circumference of the wheel is worked by a cylindrical roll. The figure shows the rolling mill as required for finishing the shape of a wheel having the section exhibited. If another shape be required, the surface of the roll is turned accordingly. — *E. von Tarlo in "Annalen für Gewerbe und Bauwesen."*

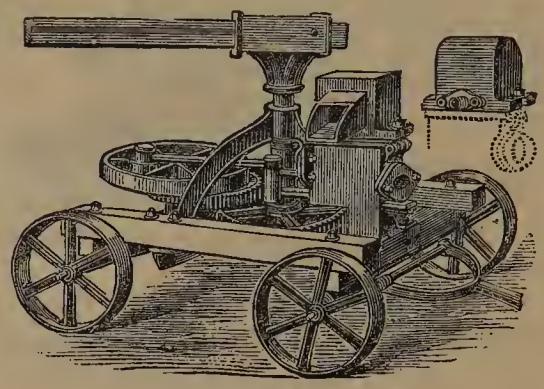
Ir'ri-ga'tion Bar'rel. A cask mounted on wheels and having an attached hand-pump for watering a garden or conservatory plants.

Fig. 1473 shows a French form in which the tonneau is in sheet iron and the pump is adapted to fill the vessel from a well or cistern and to discharge the contents of the vessel, as the case may require.

Ir'ri-ga'tion Pump. A pump for raising water for irrigation of growing crops.

Several forms are shown under various titles, such as the *Noria, Mental, Shadoof* of Oriental countries. See "*Mech. Dict.*" under these titles and references *passim*. See also list on p. 1827, *Ibid.*, and numerous examples on pp. 1825–1832, *ibid.*

Fig. 1474.



Cattle-power Pump for India.

A mounted cattle-power, a modern form of the Noria (see Fig. 3334, p. 1533, "*Mech. Dict.*") is shown in Fig. 1474, as made for the irrigation works in India.

See Irrigation in Ceylon.

Byrne . . . . . "*Van Nostr. Mag.*," xxiii. 197.
Works. Ceylon . . . "*Van Nostr. Mag.*," xviii. 52.
Southern India . . "*Van Nostr. Mag.*," xviii. 159.
Paper on, *Davidson* . . "*Min. & Sc. Press*," xxxiv. 166.
Works in Germany.
"*Builder*," . . . . "*Van Nostr. Mag.*," xx. 262.
Irrigator, *Taylor* . . . * "*Scientific American*," xxxv. 338.

Ir'ri-ga'tor. 1. (*Surgical.*) A douche. A means of applying a profuse washing to a part; rectum, vagina, uterus, etc. See SYRINGE, INJECTOR, DOUCHE, etc.

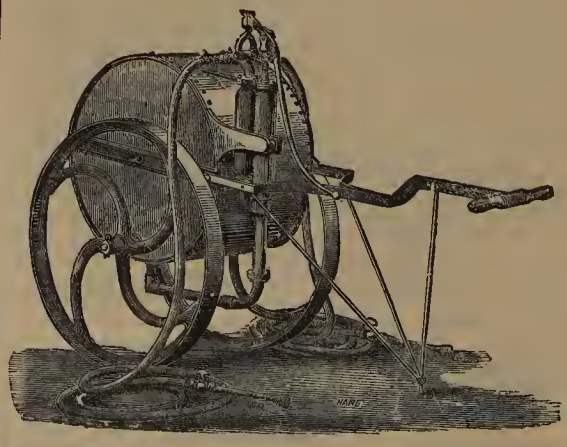
2. A watering-cart for growing crops.

In the form shown in Fig. 1475 it is a barrel mounted on wheels, and having a pump which acts as a suction-pump for supply, and a force-pump for discharge. — *Coleman & Morton*, Br.

Fig. 1473.

French Irrigation Barrel.

Fig. 1475.



Irrigator.

I'sin-glass. Fish glue. *Colle de poisson.* See ICHTHYOCOLLA.

An interesting Japanese product is the *Kanten*, or vegetable isinglass, prepared from the *Gelidium corneum*. The seaweed called *Tengusa* is carefully washed and afterward boiled, so as to form a gluish decoction, which is strained off and put into square boxes. When cooled, it forms a stiff jelly, which can easily be divided into squares of a foot in dimension The manner in which the surplus water is removed is ingenious and worthy of notice. The jelly prisms are exposed in the open air during a cold night, and allowed to freeze. During the day the sun melts the water, which runs off, leaving behind what one might term the skeleton of a white horny substance, which is extremely light, and easily dissolved in hot water; when cooled, it again forms a stiff jelly. This article, which is already to a certain extent known in Europe, can be applied to many uses, viz., for cooking purposes, for making bonbons and jellies, for clarifying liquids, as a substitute for animal isinglass, for making molds used by the plaster-of-paris workers, for hardening the same material; in short, as a substitute for all kinds of gelatines, over which it has the advantage of producing a firmer jelly. In Europe it is sold under the name of *Agar-agar.*

Another sea-weed, much used for industrial purposes, is the Fu, resembling the Carragheen moss, and applied to similar uses, such as, for instance, the sizing of the warp of silk goods See also HAITHAO.

Is'tle Ma-chine'. A machine for preparing fiber from the leaves of the *lechugilla*, a Mexican *agave*. This fiber is used in the manufacture of hammocks, sacks, ropes, nets, cotton bagging, wagon-sheets, carpets, etc.

The machine (Welke's patent, No. 171,708) is a substitute for the slow and primitive process of hand-scraping.

The invention consists of devices by which the leaves are drawn by rollers through scraping-knives, which are made to yield to the thickness of the leaves. The leaves are placed between the scrapers up to a gage-piece, and then carried with the scrapers toward the feeding-rollers. Sliding and reciprocating scraper-jaws are operated by transmitting mechanism, by the forward motion of the scraper-frame, for scraping off the ends of the leaves which are conveyed to a receiving-platform, and dropped by the same to a receptacle below.

The word *istle* is Mexican, Spanish *pita*, the *Agave Americana*. Admirable specimens of the fiber were shown at the Centennial Exhibition, in Agricultural Hall. The fibers of a species of East India banana yield *Manilla*. The *cochorus capsularius* and *C. olitorius* yield the jute of commerce; the leaves of the *Phormium tenax*, New Zealand flax, yield an excellent fiber; the East Indian *Ramie*, *Bœhmeria nivea*, one of the urticaceæ, has a stem, the inner bark of which yields a very useful fiber, used from time immemorial in China, and imported into Europe to mix with silk. *Tampico* is another fiber, the mechanical treatment of which offers the same problem. On the materials above stated, see RAMIE.

I'vo-rine Min'e-rale. A substitute by M. Roger, of Paris, for horn and ivory. It can be made to take various colors, and especially dark hues. By pressing the warm mass into forms, various useful articles, such as umbrella and cane handles, door-knobs, ink and pen-holders, buttons, etc., etc., are produced. — "*D. Industrie Zeitung.*," xix. 387.

I'vo-ry, Ar'ti-fi'cial. Various recipes are given on p. 1207, "*Mech. Dict.*," and a list of 22 patents.

Any white composition of a given mechanical consistence may pass for an artificial ivory, — white celluloid, for instance. See CELLULOID, pp. 180, 181, *supra*, where is given a list of 120 patents of celluloid, pyroxyline, xylodine, and allied compounds, and also a list of references.

See also the following under their alphabetical heads, *supra* Hints may be taken from them, recollecting that the specialty *ivory* is a mere question of the color of the composition: —

Bonesilate.	Cellulose.	Ebony, artificial.
Bois-durci.	Coral, artificial.	Hemacite.
Boulinikon.	Ebonite.	

The question of color even is not all-important, as the practice is to stain ivory for various purposes, — billiard balls, for instance

A general statement may be suggestive. Use, combined in suitable proportions, amber, Canada balsam, the Australian gum-kowrie, potato flour or fecula; and with these substances, or any of them, combine meerschaum, paper pulp, calcined bones, fluorate of gypsum or silicium, sulphide or sulphurets of mercury (vermilion), or of other metals, chlorides or carbonates of zinc, or other metals, sulphate of baryta, alkaline preparations, asbestos, fluxed or fritted colors, or finely powdered pumice-stone, sulphur, india-rubber, or similar gums.

See also PYROXYLINE, pp. 1839, 1840, "*Mech. Dict.*," where numerous patents and recipes are listed and described. To these may be added: —

Recipes: Papier-maché and gelatine; for billiard balls, moldings, and architectural decoration: add zinc white or other color. — *Dupré*, Paris. "*La Nature.*"

Ivory dust, 16, boiled in water to a jelly; add shellac, 16, dissolved in alcohol, and oxide of zinc, 1. Pour into forms, dry in the air, subject to high pressure; may be cut, sawed, or turned. — *Cohen*, London.

Calcined magnesia and caoutchouc; heated and pressed.

Cellulose, glue size, and alum water; press into molds; saturate with melted stearine and white wax; polish with a brush. More exactly —

No. 1.	No. 2.	No. 3.
Glue, 100	Alum, 100	Cellulose, 50
Water, 1,000	Water, 1.000	Water, 3,500

Take 75 of No. 1, 200 of No. 2, 200 of No. 3, and add 250 finely ground gypsum, and 100 water. Mix, fill into greased molds. Drain off superfluous water, and allow to solidify. Wash in hot water, dry, soak in equal parts of wax and stearine. Brush to develop luster. — *Harras*, Boehlen, Ger. Refer to: "*Sc. Amer.*" . xxxvi. 147; xxxvii. 258.
"*Scientific Amer. Sup.*" . 1041, 2536.
"*Iron Age*" . . . . . xviii., Sept. 1, p. 15: xix., Apr. 19, p. 1; xxiii., Mar. 20, p. 1.
"*Eng. & Min. Journal.*" xxiii. 171; xxvii. 338.
"*Manuf. & Builder,*" . ix. 192; viii. 192.
"*Telegraphic Journal*" . vi. 284.
Also: Uses of ivory . . "*Scientific American Sup.,*" 2360.
Vegetable ivory, *Costes* . "*Technologiste,*" xli. 823.

I'vo-ry Bleach'ing.

Clean the ivory by boiling it with a paste composed of burned pumice-stone and water. After cleansing place the article under a glass vessel, and expose it to the sun's rays until it assumes its original whiteness. The ivory should be kept moist with water while bleaching.

Mix a thin lime paste and heat over a moderate fire. Place the ivory in this paste, and leave it until it bleaches white, after which remove the paste, dry, and polish.

The ivory articles are placed in a solution containing 11½ ozs. carbonate of soda in crystals and 45⅝ ozs. of water, and allowed to remain in solution for two days. The articles are then removed from the solution, well washed in pure water, and then smeared for five or six days in a solution composed of 17 ozs. of sulphite of soda and 45½ ozs. of water. At the end of five or six days there should be added to the solution containing the articles an ounce of hydrochloric acid diluted with 5½ ozs. of water. The vessel containing the liquid should then be covered and left standing for from 24 to 26 hours, after which the ivory may be taken out, washed in clean water, and dried. — *Dr. Artus.*

I'vo-ry Dye'ing.

Black: Steep the article in a weak solution of nitrate of silver, and expose it to the light; or, boil the ivory first in a solution of logwood, and then steep it in a solution of sulphate of iron.

Red: Steep in an infusion of cochineal in liquid ammonia; the articles are first soaked in a water slightly acidulated with nitric or acetic acid.

Blue: Steep in a solution of indigo in sulphuric acid which has been diluted and neutralized with chalk or potash.

Green: Use a solution of verdigris in vinegar.

Yellow: Use a bath of chromate of potash, and afterward a boiling solution of acetate of lead.

Purple: Use a neutral solution of chloride of gold, and then expose to the light.

I'vo-ry Paste. (*Ceramics.*) The material of which ivory porcelain is made. The term *ivory* refers to the peculiar dull luster, made by depolishing the vitreous glaze.

I'vo-ry Por'ce-lain. (*Ceramics.*) A porcelain the vitreous surface of which has been depolished to remove the glaze, leaving the dull luster of ivory.

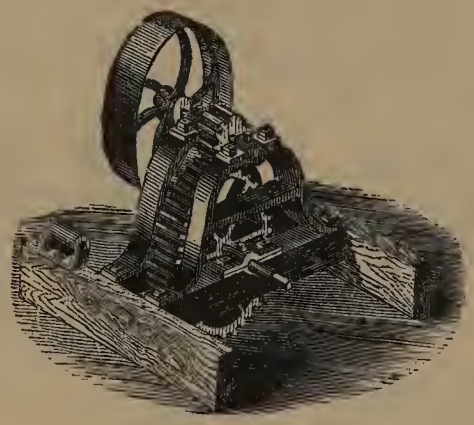
I'vo-ry Sil'ver-ing. Immerse in a weak solution of chloride of silver until of a deep yellow color; then take out and dip in water, after which expose to the sun's rays until black. On rubbing, the black surface will change to a silver.

J.

Jack. (*Add.*) 12. (*Leather.*) A machine to which may be fitted a steel, glass, or *lignum vitæ* slicker, a scouring-stone, or pebbling roller, according as the leather is to be slicked, smoothed, polished, stoned, or pebbled.

13. An intermediate motion, between a horse-

Fig. 1476.



Jack.

power and the machine to be driven. It converts the relatively slow motion of the tumbling-rod of the horse-power into a rapid pulley-motion, the latter communicating by belt to the thrasher, straw-cutter, mill, or what not.

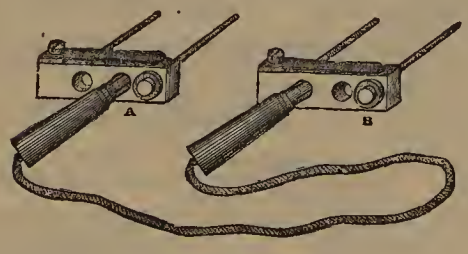
See also Intermediate Motion.

Jack'et-ed Gun. (*Ordnance.*) One strengthened by bands fitted or shrunk on to the tube proper. It is now a common mode of making ordnance; a good instance may be seen in the *Broadwell* gun, * "*Engineering*," xxi. 16. Also the Armstrong gun, Fig. 527, p. 160, *supra*.

Jack'-knife. (*Electricity.*) A form of commutator used in telephone central stations. It is a square piece of brass fixed to an upright board by means of two bolts.

The cut shows two of such commutators. The left-hand bolt in each fastens the brass block, and at the same time

Fig. 1477.



Jack Knife.

makes connection with a subscriber's wire. The other bolt is in connection with the indicator wire, but is insulated from the jack-knife, and has a small, erect pin, likewise insulated, upon which the flat spring rests. The jack-knife is then at rest; the line in communication with the indicator, the other end of the latter being in the earth.

When the subscriber sends a current, the indicator notifies the central. The jack-knife has two holes, and the operator puts a pin in hole No. 2 at *A*, connecting by a wire with the telephone.

The pin raises a peg on the spring, and, consequently, breaks the contact between the mass of the jack-knife and the indicator. The simple introduction of the pin does two things: it detaches the indicator from the line, and attaches it to the telephone. The employee then receives his instructions from the subscriber. To connect the two jack-knives of the subscribers, right and left, a flexible metallic cord terminating in two pins is used. These pins are inserted in holes 1 and 2, as seen in Fig. 1477. If one of the indicators is wanted to be in derivation, the corresponding pin is inserted in hole to the left, the spring is not raised, and the mass of the jack-knife, which forms part of the line of correspondence, is connected with the indicator and the earth.

Jack Lamp. (*Sporting.*) One for still-hunting, *weequashing* or fire-fishing, and general camp use. It is sometimes carried on the hat or helmet, but is preferably supported by standard from the belt, so as to give freedom of motion to the head in peering and sighting. It burns kerosene without a chimney.

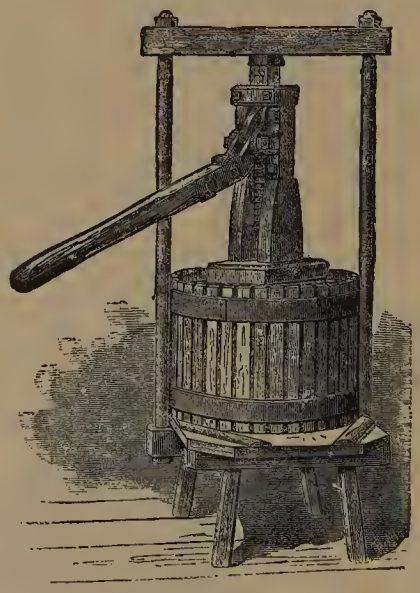
Fig. 1478.

Jack Lamp.

Jack Press. One in which a common lifting-jack arrangement is the means of applying the force. Fig. 1479 shows the ordinary lever-jack thus adapted to a wine, cider, or lard press.

Jack Screw. (*Add.*) 2. (*Dentistry.*) A small extensible instrument used in regulating the teeth;

Fig. 1479.



Jack Press.

to erect them or twist them into symmetrical order. (See Fig. 1480.)

Lifting-jack, telescopic, *Ball*. . . * "*Sc. Amer.*," xlii. 213.

Jac-quard'. See following notices:—

Barker's punching machine for Jacquard cards, noticed in "*Chambers' Journal*," "*Scientific American*," xxxiv. 133.
Double-shedding harness.
Ainley, Eng. . . . * "*Scientific American*," xxxvii. 258.

Jag'ger Spring. (*Vehicle.*) A spring beneath a seat and resting by its ends upon blocks or cleats, in the bed or body of the vehicle.

Jail Lock. A form of lock used in securing shackles or hasps to staples. Sometimes called a Scandinavian lock, or Scandinavian padlock.

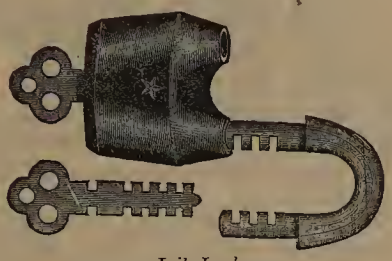
Fig. 1480.

Dental Jack Screws.

It is unlocked by a flat key, which loosens both branches of the shackle, so that they pull out, or, as in the case shown in Fig. 1481, one becomes free, and then the shackle rotates on the one which remains connected.

*Page . . . . *"*Iron Age*," xxi., January 3, p. 1.

Fig. 1481.



Jail Lock.

Jan'ney Coup'ler. (*Railway.*) A draw-bar arranged to couple cars automatically, and invented by Janney. See CAR COUPLER.

Ja'nus-faced Lock. One having duplicate faces, so as to go upon a right or a left hand door, the key entering at either side indifferently.

Ja-pan'. A kind of varnish, differing in its constituents according to the purpose required of the article treated with it, or of the nature of the process by which the article is manufactured. See LACQUER.

Baking Japans . . "*Iron Age*," xix., March 29, p. 15.

Jap'an-ese Bron'zes. These works of art are made by a process akin to those described on pp. 500 and 1462, "*Mech. Dict.*"

The models are made in wax; and in that material everything, down to the smallest feather of a bird's wing or the hair of a spider, is elaborated with scrupulous care. The wax model is then painted all over with a coating of extremely fine sand, held together by a fire-proof mucilage. The first coat is laid on with extreme care, so as to fill every tiny interstice. So with all following coats, which may number hundreds, until sometimes six months are consumed in the work of painting a cumulative mold three or four inches thick. When the latter is rendered sufficiently strong, the wax model inside is melted and removed. The bronze is then poured in, and the whole object completed in a single casting. The mold is subsequently removed with care only second to that employed in its construction, leaving the bronze without a crease or flaw. From this process emerged the magnificent incense bearer which stood at the entrance of the Japanese section at the Centennial Exhibition, 1876. It represents a vessel elevated upon worn sea rocks, inhabited by a dragon and surmounted by an eagle and flanked by flocks of birds. The price was $4,500, and it was purchased for the London South Kensington Museum.

"Statues of all sizes, bells, vases, water-basins, candlesticks, incense-burners, lanterns, etc., have been manufactured in large quantities for temples and their approaches. Portrait-statues, like the monuments erected in foreign countries to honor the memory of celebrated men, have never been made in Japan As articles for household uses, we may mention fire-pots, water-pots, flower-vases, and basins in which miniature gardens are made, perfume-burners, pencil-cases, small water-pots of fanciful shapes for writing-boxes, paper-weights, and small figures representing divinities. These bronze castings are either made in the simple and severe style of the old celebrated Chinese bronzes, or else are specimens of the peculiar character of Japanese art, which chooses its subjects from natural life, either combining them with lively scenes showing a great deal of humor together with the most minute copying of nature, or else using them to produce some artistical effect, sometimes in a somewhat capricious way, quite unexpected to the beholder. Occasionally the artist takes his subjects from Chinese and Japanese mythology, and produces all sorts of legendary animals, such as the dragon, the stork, the tortoise, etc., which are largely represented on the candlesticks and other castings used in temples, or in the domestic chapels. The bronze utensils of these latter are generally composed of 5 pieces — 2 flower-vases, 2 candlesticks, and one incense-burner." [From a Japanese author.]

Bronze castings of less elaborate design are made in the usual manner, the art being well understood in Japan where it is very ancient.

The plan adopted is similar to that now used in Europe, and described on p. 2312, "*Mech. Dict.*"

The bronze is cast in clay molds formed upon models made of a mixture of wax and resin, which is melted out from the finished mold previous to pouring the metal in. The artist who makes the model generally does the casting himself, and in most cases the work-people consist only of the master's family and two or three assistants. The melting furnaces are of exceedingly small dimensions, and generally made of an iron kettle lined with clay. After casting, the pattern is carefully corrected and worked out by chiseling, but the best bronze casters prepare the model, the mold, and the alloy in such a way as to produce a casting which needs no farther correcting or finishing.

The distinction between bronze (Jap. *Karakane* = Chinese-metal) and brass (*shin-chu*) is well understood in Japan. The spelter used in the latter is imported.

The coloring of the bronze is either for the sake of variety to suit certain tastes, or to confer the appearance of age. See BRONZE COLORING; PATINA.

Differences of opinion exist as to the nationality of the great bronze statue, the "*Daibutz*" (Buddha in Nirvana), now standing at Kamakura, Japan, and shown at Fig. 5573, p. 2312, "*Mech. Dict.*" The statue is 50′ high and is there stated to have been cast at Tolon Noor, in Thibet, probably as much as 600 years since. The statement has high authority, and the very name of bronze in Japanese is a word equivalent to *Chinese metal*, as above stated. It is, however, but fair to state that other authorities mention the casting of a large bronze statue of Buddha in the position of serene contemplation, by the order of the Japanese emperor Shomu (724–749, A. D.). It was erected, the account runs, at Nara, 743–752. Damaged by earthquake and fire it was recast about 1300, and yet exists at Nara. A second, of a later date, at Kiyoto, was destroyed by fire.

See also BELL; BRONZE INLAYING.

Jas'per Ware. (*Ceramics.*) A form of ware invented by Wedgwood, in 1773. This paste he used in ornamental and cameo work, reliefs, etc., and the name was adopted after a series of improvements which left it proximately perfect.

It was imitated and copied throughout Europe. Flaxman made designs for it, and antique works of all suitable kinds were borrowed to form molds.

Jaw Bit. (*Railway.*) A bar extending across the jaws of a pedestal underneath the axle-box.

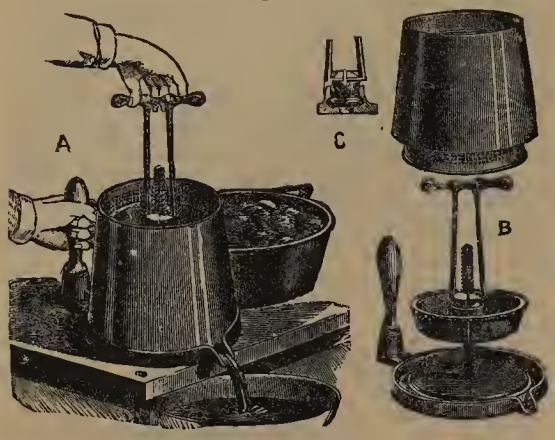
Jaw Chuck. One with movable studs on a face-plate adapted to approach and grasp the object, as in the screw and universal lathe chucks. Fig. 2833, p. 1263, "*Mech. Dict.*"

Jel'ly Pow'der. So called from its resemblance to calf's-foot jelly. It consists of 94% or 95% of nitro-glycerine and 5% or 6% collodion cotton, so mixed as to assume a gelatinous form. It is tough, but can be easily cut with knives or shears, and applied to cartridges and balls. It is waterproof, acts in the same way as dynamite, but is at least 50% stronger, and does not possess the great defect of the latter in parting with its nitro-glycerine when damp. — *Nobel.*

Jel'ly Press. A domestic hand-press for expressing juice from fruit, etc.

It consists of a guttered base upon which is an inner perforated cylinder into which the pulp is to be introduced, and an outer plain cylinder which serves to prevent any waste of the liquid pressed out. The plunger, which is shown at *B*, slides over the screw. The lower end of the screw handle, as will be seen at *C*, is split so that the han-

Fig. 1482.



Jelly Press.

dle can be pressed downward over the screw very rapidly, until the conical cap of the plunger bears so strongly upon the lower ends that they firmly clasp the screw. The greater part of the compression is thus quickly done. A few turns of the handle after it has been pressed down as far as possible, will complete the work. See also Fig. 872, p. 274, *supra.*

Jerk Net. (*Fishing.*) A folding net closed by a jerk upon a line.

Jerk Snare. A species of snare which is sprung by a line held by a party in ambush.

Jet. A solid black, glossy lignite, found principally near Whitby, in England. Also found in Spain. It is sawn, carved, bored, etc., and polished on wheels. Some cannel coal nearly approaches it. A dull kind is called *dazed jet,* as it will bear no polish.

"*Scientific American*" . . . . . xlii. 23.
*"*Scientific American Supplement* . . . . 1571.

Jet Pho-tom'e-ter. An instrument for measuring the light of a burning gas-jet.

There are two modes of working: —

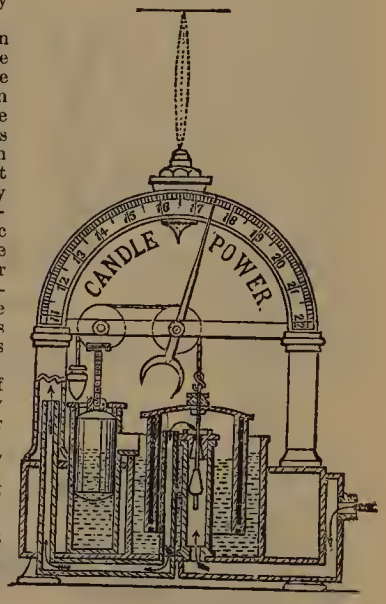
In one, the jet is regulated so as to reach a certain height, and the candle-power is shown by an index hand upon a graduated arc.

In another, it reads by an inverse method: the pressure being set at a regulated point, the height of the jet is measured as a determination of the candle-power.

The idea of ascertaining the candle-power of coal-gas by the height of the flame, while burning through a circular orifice under varying pressure originated with Mr. Lowe of London. The apparatus shown in Fig. 1483 is the American Meter Co.'s improved Lowe apparatus.

Gas is brought into and consumed from a small holder made so as to commence to rise from the water at .41 of an inch pressure, and cease at .71. The gas acting directly under the top of holder, which is of large area, causes it to rise through a space of nearly two inches by the increase of pressure from .41 to .71 of an inch, or in reality a rise of about .6 for every .1 pressure.

Fig. 1483.



Jet Photometer.

The holder, in rising, carries the pointer over the range of scale from 22 to 11, and as the gas burned at jet is taken directly from under the holder it is evident that any diminution or increase of pressure will give immediate motion to the holder and pointer, showing the exact candle power of the gas under such changes of pressure.

The height of flame is adjusted by the micrometer cock to exactly 7″.

With a flame 7″ high, ordinary coal gas, burnt at .41″ pressure, is equal to 22 candles, and at .71″ pressure, equal to 11 candles.

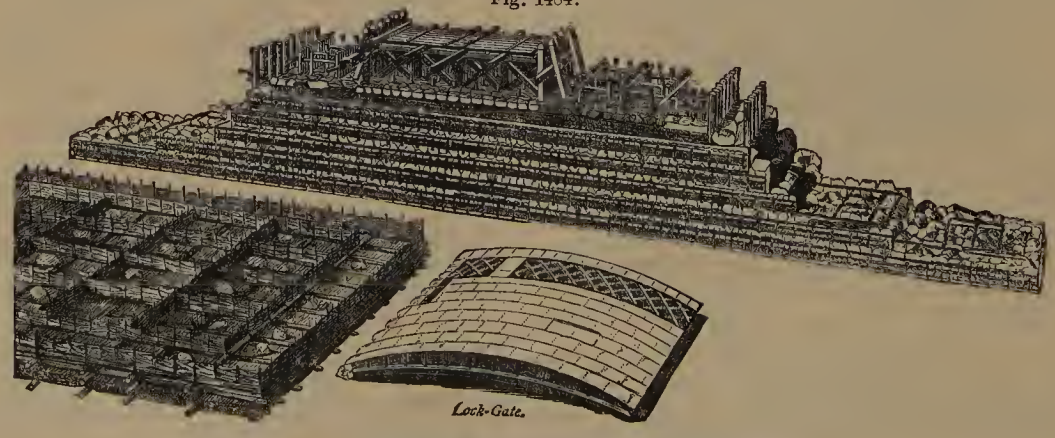
Jet'ty. Plans and sections of the jetties, rubble on mattresses, Charleston harbor improvements, are shown in the "*Report of the Chief of Engineers, U. S. Army,*" 1879, *i. 734.

Fig. 1484 shows details of the jetties of the North Sea entrance to the Rotterdam sea canal.

The principal feature is the use of the fascine mattress, common in dams and dikes on inland waters, but not before attempted in the open sea. The mattresses are made on the seashore at low water, so as to be floated off by the tide. They are made of willows and osiers, bound into fascines 10′ to 12′ long, the twigs remaining attached, making a bundle 17″ in circumference at one end and 14″ at the other. These are overlapped and tied together into long ropes called *wiepen.* To build a mattress the *wiepen* are laid parallel 3′ apart, crossed by others at the same intervals, and tied at the intersections with withes except at certain points where tarred ropes are used, to serve subsequently in binding other layers of *wiepen* to the foundation course and so on up. On this foundation bundles of twigs are laid, and then a second layer crosswise. This is followed by two layers of *wiepen* at right angles, like the former, and tied to the preceding by the tarred ropes. Stakes are driven in and baskets woven on the stakes to hold the ballast, and other stakes to form bollards for towing and mooring. The mattress is towed to the spot, anchored, and then sunk by simultaneously loading its whole surface with stone from small vessels all around it. 350 to 700 lbs. of stone to the square yard is the ballast for the mattress. Other mattresses are added until the required height is reached.

The head of the southern jetty is 82.5′ wide and 3.3′ height

Fig. 1484.



Jetty at North Sea Entrance Rotterdam Sea Canal, Netherlands.

above mean low water mark. 10′ above that level is a timber platform supported on piles. The platform is 25′ wide, and carries a railway track. The sides of the jetty are stone-faced.

See Boulogne	*	"*Scientific American Sup.*," 2396.
		"*Scientific American*," xxxix. 153.
Charleston Harbor		"*Scientific American*," xxxix. 293.
Galveston Harber	*	"*Scientific American Sup.*," 245.
Malta	*	"*Engineering*," xxv. 576.
Mississippi, maps & profiles	*	"*Scientific Amer. Sup.*," 328, 435.
		"*Scientific American*," xxxiv. 80.
		"*Scientific American*," xxxv. 273.
Levees, Miss.		"*Scientific American*," xxxiv. 160.

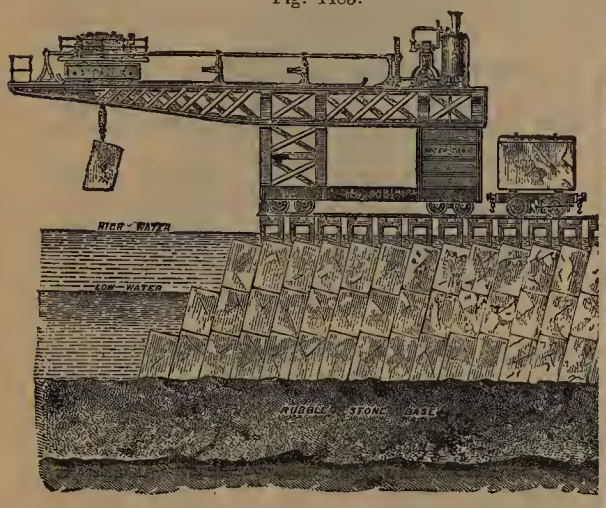
See also APRON, Fig. 103, p 44, *supra*.

Jet'ty Crane. A form of crane for building jetties of blocks.

That shown in Fig. 1485 is thus described by the engineers: —

"The object of the crane, appropriately called a *Titan*, is to lift blocks of from 20 to 30 tons' weight from the trucks

Fig. 1485.



The "Titan," Jetty Crane.

and place them in position *in advance* of the finished work, and thus to dispense entirely with the use of staging; it was first used for this purpose in the Manora Breakwater. The Titan, illustrated in Fig. 1485, fulfills all the conditions indicated when tenders were invited for the work.

"These conditions were, that the blocks, each weighing 27 tons, should be lifted, traversed out, and placed in position 25 feet in advance of the point of support afforded by the finished work. The main framing is made throughout of wrought iron, and travels on a pair of rails, 22′ gage, which were carried on blocking pieces up to the front face of the work, as shown in the engraving: the height from rail level to the upper side of the projecting girders is 20′. The lower members are of box-girder section, and are fitted on each side with two pairs of wheels placed close together, fore and aft, traveling on the rails above named, and the front group can be relieved of the strain due to the weight of the block, by powerful short-stroke hydraulic jacks placed under the front end of each girder.

The engines are two 7″ cylinders with link-reversing motion; the boiler is of the vertical type, and the several motions for lifting and traversing the load, and for moving the Titan, are transmitted by suitable shafts and gear with the necessary clutches and levers. The engine and boiler are mounted on a platform laid on the transverse girders, tying the two frames together; a pair of wrought-iron tanks, capable of holding 30 to 40 tons of water ballast are fixed over the trailing wheels, and form part of the framing. The cost of the *Titan* is £2,500, the weight 85 tons, and the duty, 6 blocks laid per day, allowing for the time required for the divers to place the blocks under water.

"The cost of the 10 trucks, which were required for bringing the blocks from the drying ground, was £180 each, and the weight 7 tons each.

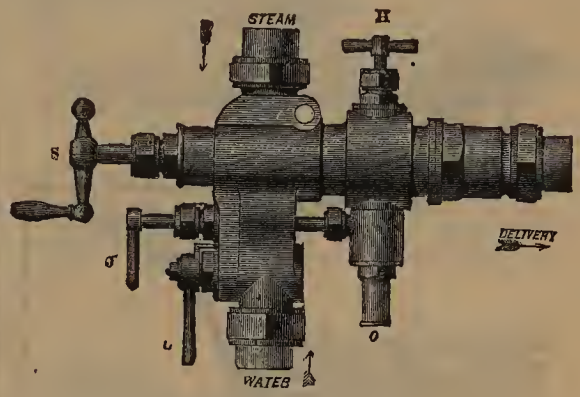
"A convenient form of *Goliath* for lifting the blocks, after they are dried and are required for use, is one with a direct-acting hydraulic cylinder and ram of the stroke required to lift the block on the trucks, the ram and cylinder being mounted on a traveling jenny with an engine and boiler of sufficient power to give the traveling motions and to work the hydraulic pumps. The cost of this for 50′ span is £1,150, and the weight 30 tons.

"Since the work above referred to was designed, it has been found necessary to use blocks weighing 40 tons, and the *Titan* for laying them has a swinging jib of about 50′ radius, carried on a frame somewhat similar to that already described; the jib is provided with swinging gear, and describes an arc of about 190°, and will lay stones across a face nearly 100′ wide." — *Appleby*.

Jet Valve. A valve in the lifting injector which is used in starting the injector.

In Fig. 1486, *J* is the jet valve; *S*, steam-valve; *L*, lazy cock; *H*, heater cock. To start, open jet *J;* when water ap-

Fig. 1486.



"*Monitor*" *Lifting Injector.*

pears at overflow *O*, open valve *S* and close *J*. To stop: close valve *S*.

To heat water in tender: close *S* and open *H*.

Jew'el-er's Ce-ment'.

Turkish: Dissolve five or six bits of gum-mastic, each the size of a large pea, in as much spirits of wine as will suffice to render it liquid. In another vessel dissolve in brandy as much isinglass, previously softened in water, as will make a two-ounce vial of strong glue, adding two small bits of gum ammoniac, which must be rubbed until dissolved. Then mix the whole with heat. Keep in a vial closely stopped. When it is to be used, set the vial in boiling water. Known to the trade as *diamond* cement.

Jewelry, electric, French	*	"*Sc. Amer.*," xli. 263.
Furnace (East Indies)		"*Sc. Amer.*," xxxvi. 169.
Manufacture		"*Sc. Amer.*," xxxvii. 308.
Setting, platinum, *Ripley & Co.*	*	"*Sc. Amer.*," xxxviii. 217.
Jade		"*Sc. Amer.*," xxxiv. 49.
Jet mining		"*Sc. Amer. Sup.*," 653.

Jew'el-er's Forge. A small forge with pedal blast and circular table; with charcoal grate or gas pot, according to circumstances. See references under FORGE, p. 354, *supra*.

Jew'el-ing Rest. (*Watchmaking.*) A tool for setting jewels in plates or settings. It calipers each jewel separately, and turns a recess to fit.

See WATCHMAKER'S LATHE, where it is shown in connection with a universal head. See JEWEL-SETTER, "*Mech. Dict.*"

Jib Crane. A crane with a projecting arm; as in Fig. 1408, p. 478, *supra*. See also Figs. 1504–1507, pp. 642, 643, "*Mech. Dict.*," and Fig. 1489, next page.

Fig. 1487.

A convenient form for foundry use, has a mast of cast-iron and a jib of wrought plate iron in two pieces. A device retracts the jib when required, as when columns, belts, or other obstacles are in the way.

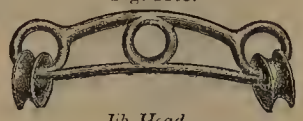
Pratt & Whitney.
* "*Iron Age*," xxiv., Sept. 11, p. 1.

Jib Hank.

Jib Hank. (*Nautical.*) A ring on the leech of a jib and which slips on the stay.

Jib Head. An iron used at the head of a jib when the latter has been stretched too much. The jib is shortened at the head and the jib head attached to the sail; clew thimbles are at the ends.

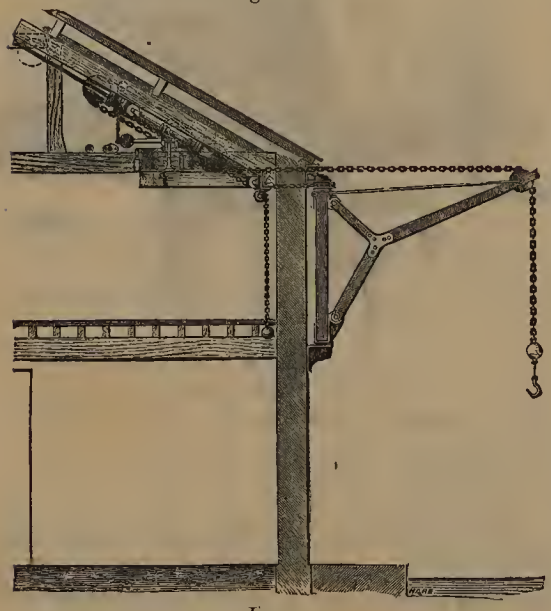
Fig. 1488.



Jib Head.

Jig'ger. (*Add.*) 7. A simple form of warehouse crane. The power is a hydraulic ram fixed

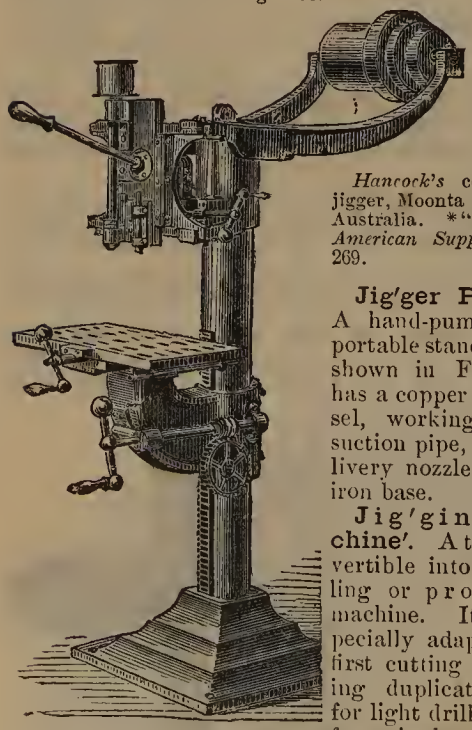
Fig. 1489.



Jigger.

to the timbers of the roof. A supplementary power is used to turn the jib when the load has been lifted the required height.

Fig 1490.



Hancock's copper-ore jigger, Moonta mines, S. Australia. * "*Scientific American Supplement*," 269.

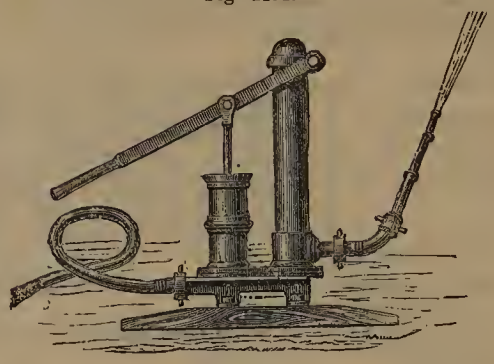
Jig'ger Pump. A hand-pump on a portable stand. That shown in Fig. 1491 has a copper air-vessel, working lever, suction pipe, and delivery nozzle, all on iron base.

Jig'ging Machine'. A tool convertible into a drilling or profiling machine. It is especially adapted for first cutting or making duplicate dies, for light drilling and for single spindle profiling.

Jigging Machine.

Jig Saw. A tool, the precursor of the band-saw. It is a fine reciprocating saw, cutting on the

Fig 1491.



Jigger Pump.

down-stroke, elevated by a spring, and kept taut between the latter and the pitman or crank-pin whence it derives its motion. See also Scroll Saw.

Figs. 4768-4770, p. 2077, "*Mech. Dict.*"

Richards, Br. . . . . * "*Engineering*," xxii. 238.
Jig-saw spring . . . . . * "*Man. & Builder*," xi. 196.

John'ite. An explosive:—

Nitrate of potassium	75
Sulphur	10
Lignite	10
Picrate of sodium	3
Chlorate of potassium	2
	100

Join'er. A wood-working machine capable of a variety of work. See Fig. 2726 and description, p. 1217, "*Mech. Dict.*"

General, *Reynolds*, Br. . . * "*Engineer*," xlv. 417.
Universal, *Rasse* . . . . * "*Iron Age*," xx., Dec. 27, p. 1.

Join'er's Bench Stop. An abutment on the bench against which the work rests in planing. See Bench Stop, Fig. 294, p. 96, *supra*.

Join'er's Clamp. A device for holding a piece while being worked; or holding parts together after being glued.

Fig. 1492.

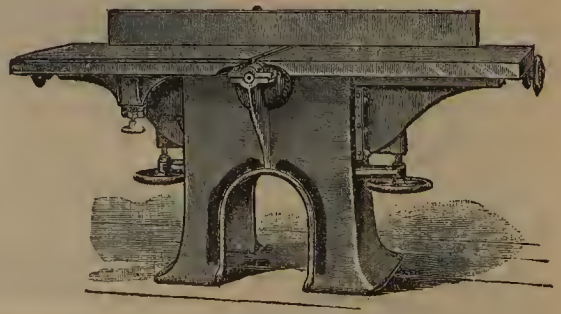
Clamp.

See Bench Cramp, Fig. 286, p. 95; Clamp, p. 560, "*Mech. Dict.*"; Cramp, p. 641; Carpenter's Clamp; Door Clamp, etc., *Ibid.*

The little clamp, Fig. 1492, is a two-fingered instrument adjusted in an instant, and fastened by a tap of the hand.

Joint Bolt. A bolt used for fastening two timbers, one end-wise to the other. A nut is inserted in one, and the hole bored through both. Used commonly as a fastening for a bed-rail to the bed-post. See Joint-holder Bolt.

Fig. 1493.



Smith's Stave Jointer.

Joint End. (*Vehicles.*) An iron piece with hole for a bolt; being united to the wooden portion, it forms the end of a carriage bow; or to a rod, forms the end of a stop prop.

Joint'er. A machine for edging staves and headings.

The old-fashioned jointer was a long plane, set obliquely with one end on the ground.

In the modern jointer the tool revolves and the stave is on a rest.

In Smith's jointer, Fig. 1493, the stave is run along the straight bed, against the fence, and the revolving tool planes the edge. The tool is a true planer, and has many shop uses besides jointing. By change of cutter the machine may mold, rabbet, chamfer, etc.

Fig. 1494 is Trevor's jointer. The plane bits are set ob-

Fig. 1494.

Stave Jointer.

liquely in the face of the wheel, and the stave lies upon the horizontal rest.

See also Fig. 218, p. 78, *supra.*

Stave jointer, *Holmes* . . . . * "*Engineer*," xli. 431.

(*Add.*) 4. (*Plow.*) A small share in advance of the main plow body; designed to overturn weeds

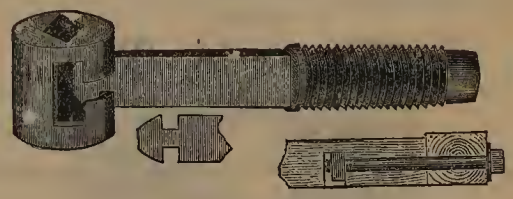
Fig. 1495.

Gale's Jointer Plow.

and double them up so as to be more completely covered in the furrow.

Joint-hold'er Bolt. A furniture joint. Used in bedsteads, especially in fastening the rails to the posts.

Fig. 1496.

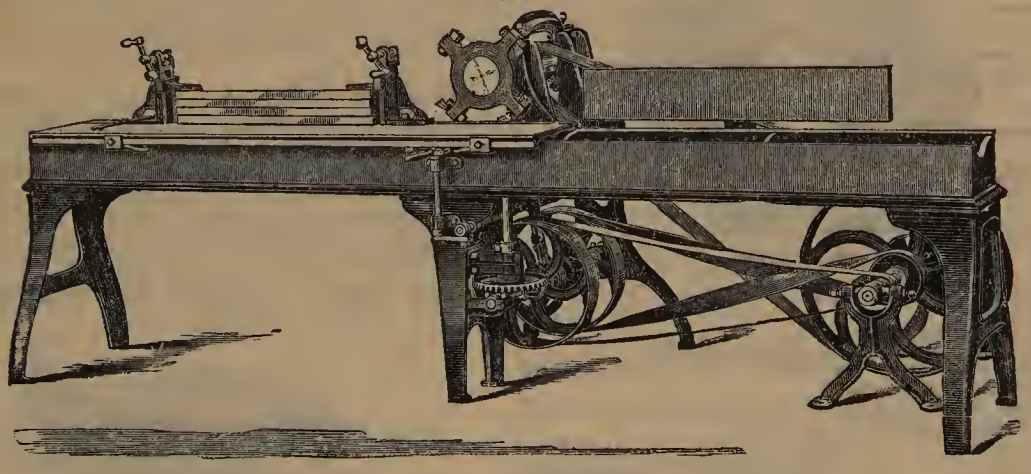


Joint Holder Bolt.

Two forms are shown: in the upper one, the socket is mortised into the side of one member of the frame and the bolt screwed into the end of the other. The notch-headed bolt being inserted into the channel of the socket and the latter rotated, the parts are indissoluble by direct draft.

The other bolt passes through both members and into a nut introduced at a side mortise.

Fig. 1497.



Cabinet Jointing Machine.

Joint'ing Ma-chine'. A planing machine adapted to a special class of work, as in furniture and piano factories, for instance.

The working parts of Rogers' cabinet jointing machine are: a table 6′ long, on which the work is placed against a back gage and held firmly by adjustable screw-clamps; the feed then being thrown into gear by the lever in front, the work is carried against the revolving cutter head, the table reversing its motion, and stopping on its return automatically. The work is finished perfectly square and ready for glueing if desired. This machine leaves all the corners of work perfectly square and unbroken.

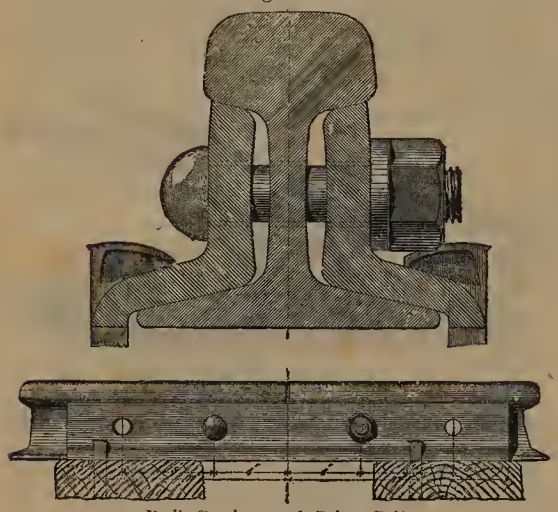
Joint Splice. A reënforce at a joint to sustain the apposed parts in true relation.

Fig. 1498 shows a standard rail section and fish plate of the Pittsburg, Cincinnati, and St. Louis Railway. The upper view is a vertical section, and the lower an elevation on a much reduced scale.

Jon'val Tur'bine. The turbine with *downward* discharge; in contradistinction to the Fourneyron *outward* flow, and others which are oblique, double, combined, etc. See Fig. 6784, p. 2657, "*Mech. Dict.*"

Jour'nal Bear'ing. The French *palier glissant* is shown at Fig. 3496, p. 1599, "*Mech. Dict.*" Bramah was the original inventor. See also Hydraulic Pivot; Water Bearing, "*Mech. Dict.*"

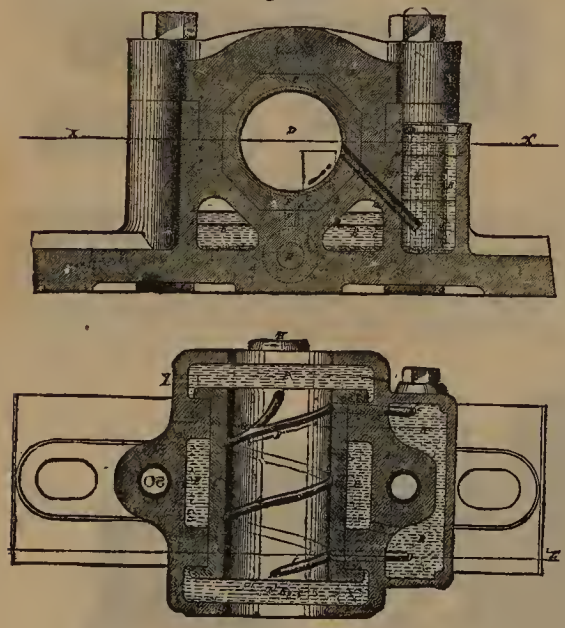
Fig. 1498.



Rail Section and Joint Splice.

The *palier graisseur sans mèche*, of Hignette, Paris, is shown in Fig. 1499.

Fig. 1499.



Journal Bearing.

A is the body of the bearing.
B, cap-piece.
C C, lining blocks.
G, helicoidal groove cut in the bearing linings.
A bifurcation assures the passage of the oil in whichever direction the shaft may run.
The reservoirs, lateral and lower, communicate by tubes with the grooves in the journal bearing.

Renewable, *Platt* . . . * "*Iron Age*," xxiv., Oct. 30, p. 11.
Marine engine . . . "*Scientific American*," xxxix. 216.
Cooler, *Dempsey* . . . * "*Scientific American*," xli. 323.

A material, a bad conductor of heat, invented by S. Coline, a French engineer, is designed for the bearing of all kinds of machines, wheels, and axles, and is stated not to require any lubrication. The following is the recipe for the composition : —

Take about 25 per cent. of asbestos, and the same of graphite, mix them very intimately and carefully ; add sufficient liquid silicate of soda or potash to reduce the whole to a half dry paste, which must then be submitted to the action of a hydraulic or other press, till it is converted into a solid mass, which is afterwards dried either in a furnace or by exposure to the air, until all moisture has disappeared. The bearings may either be turned out of the block or molded from the composition while in the moist state. When the bearing is finished it is steeped in hot melted paraffine, mineral wax, or in a solution of paraffine, benzole, or other mineral oil, until all the pores in the composition are filled.

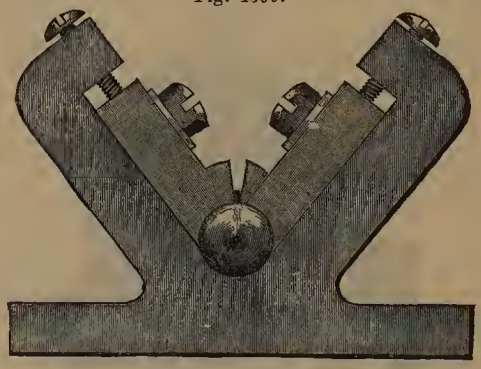
Jour'nal Bear'ing Key. (*Railway.*) A plate on top of axle box to hold the latter in plate. See 8, Axle Box.

Called also *wedge, liner, slide, saddle, keeper*, etc. — *Forney.*

Jour'nal Box. (*Railway.*) A metallic box which incloses the journal of a car-axle, the brasses and the key. See Axle Box.

Ellis's journal box is shown in Fig. 1500, and is made in three parts, the upper two of which are separately adjustable toward the journal, permitting the latter to be kept central and tight.

Fig. 1500.



Adjustable Journal Box.

Jour'nal Brass. The bearing or box of a journal or axle.

Jour'nal Pack'ing. (*Railway.*) Waste cotton or wool saturated with oil or grease and filled into an axle-box to lubricate the axle.

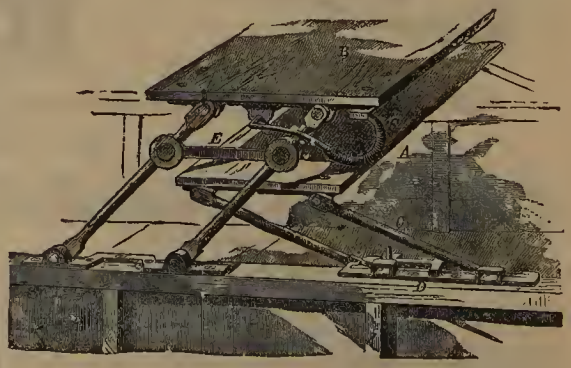
Jour'nal Spring. (*Railway.*) A spring which supports part of the weight of a car and is placed directly over the journal, and which usually rests on the journal box under the truck-frame. Such springs are sometimes placed above the truck-frame and supported by straps, and the weight of the car is transmitted to the journal box by a vertical pin or stirrup. — *Forney.*

Ju'lep Strain'er. A round or oval ladle with corrugated and perforated surface, for straining a drink passing from one glass to another.

Jump'er Stay. (*Nautical.*) A movable stay leading from the head of a main-mast to a pair of eye-bolts in the deck close to the after part of the fore rigging, the weather jumper stay alone being set up.

Jump Seat. (*Vehicles.*) An adjustable seat

Fig. 1501.



Jump Seat.

which may be brought into position for use when it is desired to convert a single-seated vehicle into a double-seated one.

In Fig. 1501 the seat *A* is shown out of use, in position below the seat *B*. When two seats are required, the seat *A* is thrown forward on its pivoted supports *C* and the seat *B* thrown backward on its pivoted supports which are braced together by the bar *E*. The supports of the front seat *A* are secured by a latch to the plate *D*, and the seat may be removed entirely if desired.

Junk Hook. (*Fishing.*) Used in hauling heavy pieces of blubber on deck.

Junk Vat. (*Leather.*) A large vat into which is pumped the tan liquor or ooze which has been deprived of a great part of its strength in the layers. The liquor is run into the stringers where a weak ooze is required.

Ju'nod's Arm. (*Surgical.*) A dry cupping apparatus. See CUPPING; ARM.

Ju'pon. (*Fabric.*) A French dress goods made on a taffeta loom. It has a simple cotton warp and carded wool weft.

Ju'ry Mast. (*Surgical.*) *Sayre's* apparatus for supporting the head by means of head and chin straps, and a spinal bar which rests below upon bands encircling the body. Fig. 194, Part IV., *Tiemann's "Armamentarium Chirurgicum."*

Jute. Fiber of the *Cochorus capsularis* and *C. olitorius;* an East India plant. Useful for many purposes in India. See p. 1221, *"Mech. Dict."*

Jute, on, *Lockert* . . .	"*Technologiste,*" xli. 171.
Ramie machine, *Favier*	"*Technologiste,*" xli. 26.
Ramie, *Léger*	"*Technologiste,*" xxxix. 117.
Jute carding engine . .	* "*Scientific American Sup.,*" 1681.
Jute machinery, *McKean & McGrath*, Br.	* "*Engineer,*" xliii. 196. *Laboulaye's* "*Dictionnaire,*" ii., ed. 1877, *Cap.* "*Jute.*"
Jute manuf., *Fleming* .	"*Sc. Am. Sup.,*" 738, 2180, 3928.

The product of the jute fiber by the Sachs process is known as *Kalameit*, which see. See also AGAVE; ISTLE; RAMIE; TAMPICO, etc., "*Mech. Dict.*," and herein.

K.

Kal'a-meit. The name adopted for the fiber of jute as prepared by the Sachs process, for textile manufactures made by the Barrow Flax and Jute Co. (Br.), and shown in the shape of curtains, table-cloths, and dress goods at the Paris Exposition, 1878. See JUTE, *supra.*

Ka-lei'do-scope. An improved form has been made by M. Thomas, of Paris.

The two mirrors are, as usual, put in a tube; but the objects employed to produce the images are inclosed in a transparent case, which is separate from the tube. This case, almost flat and with its two faces formed of watch-glasses, is supported by a rod, which is fixed to the tube by a hinge. It can also receive a movement of rotation round its axis of suspension. In this way it can be inclined in any direction to the axis of the tube. A button, manipulated with the hand, enables one to turn it about its center, so as to change the positions of the objects within. A pasteboard disk, white on one side, black on the other, is placed behind the case. Transparent or opaque objects may thus receive light on one or the other side of the case and be displayed on the white or black background of the disk, according as it may be desired to observe them by transmission or reflection. — "*Société d'Encouragement,*" *Paris.*

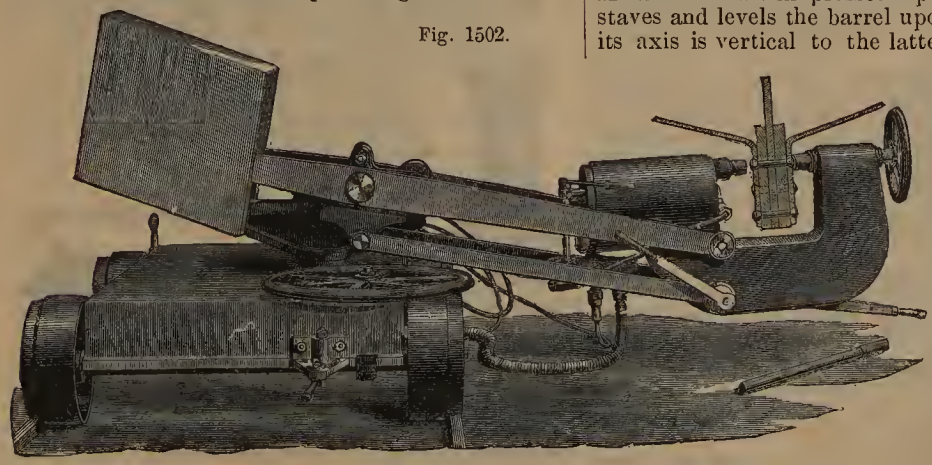
Kedge. (*Nautical.*) A small anchor used in warping; to keep a ship steady and clear of her bower when riding, etc.

Kedg'ing. (*Nautical.*) Tide-working in a narrow channel or river by kedge-hauling.

Keel Riv'et-er. A machine for riveting the keels of iron vessels upon the stocks.

Fig. 1502 shows Tweddell's hydraulic keel-riveter, as made by Fielding & Platt of Gloucester (Br.), and used at the Barrow Shipbuilding Co.'s works.

Fig. 1502.



Tweddell's Hydraulic Keel Riveter.

A short length of tramway is laid under the vessel and alongside the keel, and upon this travels a bogie or carriage carrying the riveter. This riveter is attached to one end of a pair of levers, and is balanced by a counterweight on the other end. Thus balanced, the riveter is easily moved up and down as required to meet not only the varying heights of the keel from the ground level, but also the different positions of the rivets themselves. The arrangement of levers is attached to a small carriage which is free to travel inward and outward along a pathway on a species of turntable, and this turntable is supported on a large pin which is free to revolve on a socket on the traveling bogie or carriage. By this means the riveter can be readily moved to or from the keel bar, which is sometimes necessary owing to the rails not being laid exactly parallel to the keel, and to other causes, while the whole apparatus can be turned round on its carriage.

A hand-wheel behind the cupping die on the *hob* of the riveter turns a screw, which takes the thrust of the die upon closing a rivet. By this means, when the hot rivet is put in, the screw being turned inward a slight pressure is brought to bear on the rivet head, and the machine is thus steadied in position. Keel rivets having very shallow heads, the rivets also being countersunk, some such contrivance as this is necessary to insure fair work. The riveting die is close to the top of the cylinder; this gives room when the garboard strakes come nearly at right angles to the keel.

The keels of the large steamships "City of Rome" and "Servia" were riveted by these machines.

"*Engineering*" . . . . . * xxx. 535.

Keep'er. (*Electricity.*) *Keepers*, also known as *shoes* (*Ganot*), are lateral projections from the polar extremities of a magnet to bring them in closest possible proximity to the revolving armature short of actual contact.

Keg Lev'el-ing and Truss'ing Ma-chine'. A machine which presses upon the ends of the staves and levels the barrel upon the table so that its axis is vertical to the latter; the staves being practically of a length, it also forces them endways, so that they are in range at the chine.

Holmes's machine is shown in Fig. 1503. The truss hoops are put on the keg in setting up, and the keg placed in the machine. The truss-hoop drivers are attached to two plates, one of which forms a stationary table and is adjustable for various sizes of kegs; and the other is moved to and from it perpendicularly. The drivers move automatically in and out, to

allow the reception and discharge of the keg into and from the machine. The plates level and the drivers drive the truss-hoops at one and the same operation upon the keg, by the movable plate being brought in contact with the upper end of the keg by the action of the cranks and pitmans, the two cranks being on the same shaft. The machine has a capacity for 4,000 kegs per day.

Fig. 1503.

Keg Leveler and Trusser.

Keg Ma-chines'. See list under BARREL MACHINERY.

British, *Ransome.*
* "*Engineering*," xxvii. 552.

Keg-shaped' Spi'ral Spring. (*Railway.*) A coiled steel-rod spring; bulging — key-fashion — from the true cylindrical form.

One with a bulging waist or middle portion; the opposite of *spool-shaped.*

Ker'a-tome Scis'sors. (*Surgical.*) Another name for *iridectomy scissors. d*, Fig. 4672, p. 2054, "*Mech. Dict.*"

See KERATOME, p. 1223, IRIDECTOME, p. 1195, "*Mech. Dict.*"

Ker'o-sene. (*Wax-light.*) From κηρός, wax, and a customary termination, as in camphene, paraffine, gelatine, etc.

The trade-mark name of the hydro-carbon oil, made for lighting purposes by the "Downer Kerosene Oil Company."

The distillation of petroleum gives a large number of products, which are known in a practical way by their gravity and flashing points.

	Gravity — *Beaumé.*
Gasoline	90° — 80°
Benziue	74° — 68°
Naphtha	65° — 62°
Kerosene	59° — 38°

Between the ranges 59°–38° the oil, when purified by chemical treatment, is sufficiently mobile and colorless to be suitable for burning in ordinary flat-wick lamps. The fire-test of the 59° B. is 90° Fah., and that of the 38° B. = 200° Fah.; between the stated limits are numerous grades capable of segregation, but for practical purposes they are combined, with a result of a fire test quality for the whole of 150° Fah.

The lighter grades of petroleum, having the gravity 90° –80° B., are used in the apparatus for carbureting air and gas. The grade known as *benzine*, 74°–80° B., is a substitute for turpentine in paint, and is largely used in scouring and cleaning. *Naphtha*, 65°–62° B., is used in paints and varnishes, and also as a solvent for caoutchouc.

The kerosene oil known as *Mineral Sperm* (Downer Kerosene Oil Co.) has a specific gravity of 36° B., and a fire test of 300° Fah. It is as safe as fatty oils, and is burned in lamps of special construction.

The still heavier products, 32° to 22° B., making in the mixture 24°–26° B., are lubricating oils, and yield from 20 to 25% of paraffine wax, which has to be removed in order that the oil may remain fluid.

Ker'o-sene Stove. See PETROLEUM STOVE, Figs. 3664, 3665, p. 1676, "*Mech. Dict.*"

Ker'o-sene Test'er. See PETROLEUM TESTER, Fig. 3666, p. 1676, "*Mech. Dict.*"

Ket'tle. A boiler. That shown in Fig. 1504 is a compact form of double-bottomed boiler, the space being heated by steam introduced through the trunnion on which the kettle may be tipped to discharge its contents. Used as an agricultural or laundry boiler.

Kier, boiling and bleaching, Br. . "*Sc. Amer. Sup.*," 1684.

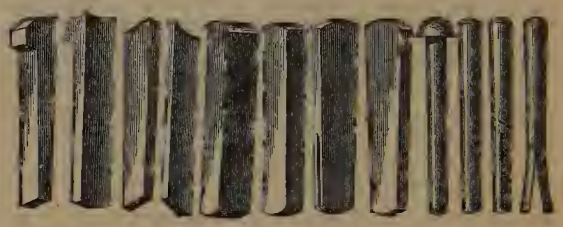
Fig. 1504.

Double-bottomed Bascule Kettle.

Key. A fastening piece to secure parts; a gib or spline, a forelock, a pin, a cotter, as the case may be. See the above definitions in "*Mech. Dict.*," and Fig. 2742, p. 1225, *Ibid.*

Fig. 1505 shows a number of forms: headed, plain, taper, stud, bracket, split, etc.

Fig. 1505.



Keys.

See also: —
Ancient, Munich . . * "*Scientific American*," xli. 25.
Fastener, *Johnson* . . * "*Scientific American*," xliii. 54.
Screw-headed, *Oliver* . * "*Scientific American*," xxxix. 121.
Keyways, cutting, *Rose* * "*Scientific American Sup.*," 1255.
Drilling, *Sharp, Stewart & Co.*, Br. * "*Engineer*," xli. 187.
Fitting, *Rose* . . . . "*Scientific American Sup.*," 888.

Key Grind'ing. An application of the emery wheel to the dressing of keys, cotters, splines, gibs, etc. See reference to many machines of the class, p. 312, *supra*; and Fig. 6083, p. 2458, "*Mech. Dict.*"

Key'-head Bolt. One with a protuberance on the chamfer of its head, to prevent its rotation when the nut is revolved.

Fig. 1506.

Key-head Bolt.

Key'-seat Rule. An instrument by the aid of which parallel lines on shafts for key-seats, mortises, etc., can be readily and accurately drawn.

Fig. 1507.

Key-seat Rule.

Key'-way Cutter. A species of planing machine for cutting seats in the center holes of wheels and pulleys. See Fig. 2748, p. 1227, "*Mech. Dict.*"

See also French . . . * "*Engineering*," xxi. 88.
On cutting and fitting . * "*Sc. American Sup.*," 888, 1255.
Drilling, *Sharp, Stewart & Co.*, Br.
* "*Engineer*," xli. 187.

Kib'bling Mill. A hand grinding-machine for mashing grain for stock. By it oats, etc., are flattened and broken, so as to insure more perfect digestion.

Kiln. A furnace for baking, fritting, calcining, firing, etc. See —

Brick.	Malt.
Faïence.	Pipe.
Porcelain.	Pottery, etc.

Fig. 1508.

Kibbling Mill.

King'-bolt Plate. 1. (*Railway.*) A plate on the floor of a car concealing the head of the king-bolt, which may be withdrawn when the cover is removed.

2. (*Carriages.*) A plate on the fore axle of a vehicle bushing the hole through which the king-bolt passes.

King'-bolt Tie. (*Vehicles.*) A saddle piece on a king-bolt, having opening at the ends for clip bolts.

Kite. A form of kite for lifting a person from the ground in order to reconnoiter an enemy's position, has been tried at Chatham, Br. The invention of Mr. J. Simmonds. A series of kites of relatively increasing size are flown, one attached to the other in series, the first assisting in flying the second, and so on. "*Iron*," viii. 300.

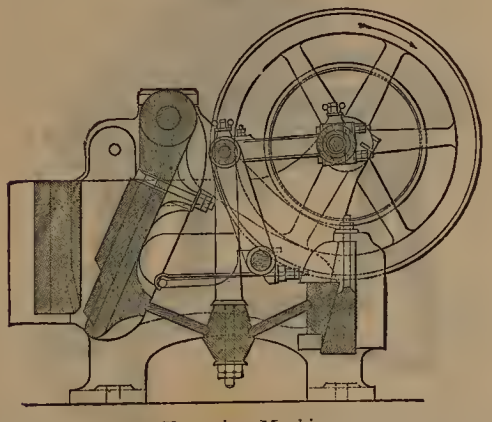
Knap'ping Ham'mer. A soft steel hammer, disk shaped or sharp edged, for breaking flint flakes into lengths for gun flints.

See *Evans'* "*Ancient Stone Implements of Great Britain*," p. 17, *et seq.* See GUN-FLINT.

Knap'ping Ma-chine'. A form of stone-breaking machine in which the stone is broken by a sudden blow, rather than by a sustained pressure, which is said to have the effect of more evenly cubing it, and producing less chips and dust.

The motion in the Baxter (Br.) machine, Fig. 1509, is obtained by a crank radius-link and lever. The blow is given by a quarter revolution of the fly-wheel shaft, the jaw remains stationary half a revolution, and retires during the remaining quarter.

Fig. 1509.



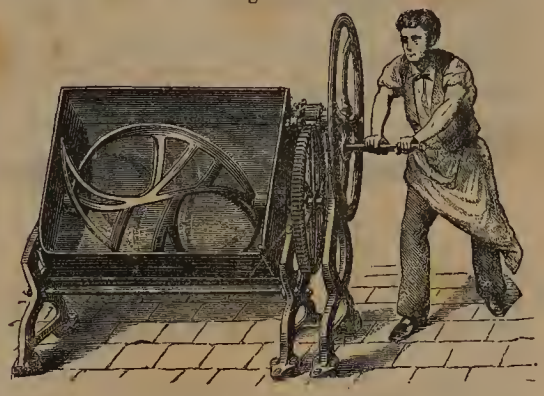
Knapping Machine.

Knead'ing Ma-chine'. A machine for incorporating the ingredients of dough.

See DOUGH BRAKE, Fig. 858, and DOUGH MIXER, Fig. 859, p. 270, *supra*.

Boland's kneading machine, shown in Fig. 1510, is an endeavor to approximate in machinery the action of human arms. The hand process has a dividing and rolling action; the hands in contact, and the arms bowed, a sweeping motion is made obliquely down through the mass of dough, which is divided, turned over, and thrown on top of the remainder. Until the mass attains a certain amount of solidity the action is principally as described, and may be compared to the beating of eggs with a spoon in a bowl, the mass being divided, and one portion flirted on top of the remainder. The action of the machine is a very close imitation of the human arm method.

Fig. 1510.



French Kneading Machine.

The subsequent pommeling of the tough dough can be dispensed with in great measure, as the capability of the machine for cutting and mixing the dough and slapping the masses together is much greater than that possible with large quantities by the human arms.

Knee Ap'pa-ra'tus. (*Surgical.*) Apparatus for fracture, luxation, weakness or deformity of the knee.

See ANCHYLOSIS APPARATUS, Fig. 202, p. 99, "*Mech. Dict.*"; PATELLA APPARATUS, Fig. 3567, p. 1636, *Ibid.*

Also, KNOCK-KNEE BRACE, BOW-LEG BRACE, etc., referred to under CURVATURE APPARATUS, *supra*.

See, also, GENU-VALGUM BRACE, p. 397, *supra*.

See, also, Patella Apparatus. Figs. 119–121, Part IV., *Tiemann's* "*Armamentarium Chirurgicum*."

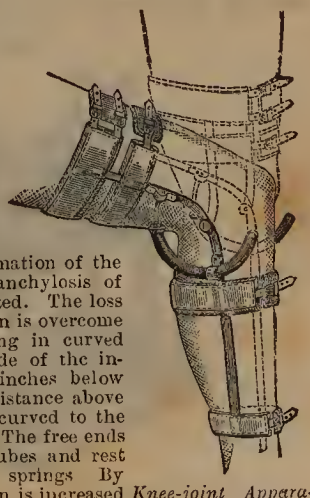
Anchylosis Apparatus, *Ibid.*	Figs. 90–92.
Sayre's knee-joint apparatus, *Ibid.*	Figs. 93–97.
Sayre's knee compressor, *Ibid.*	Fig. 195.
Andrews' splint, *Ibid.*	Fig. 188.
Andrews' straightening apparatus, *Ibid.*	Fig. 190.
Holthouse's extender, *Ibid.*	Fig. 145.
Hooper's extender, *Ibid.*	Fig. 80 *b*.
Hutchinson's apparatus, *Ibid.*	Figs. 94, etc., Sup.
Stillman's splint, *Ibid.*	Figs. 95, etc. Sup.

Knee Cap. (*Surgical.*) A water or ice-bag for topical applications to the knee.

Knee'-i-ron. An angle-iron at the junction of timbers in a frame.

Knee'-joint Ap'pa-ra'tus. (*Surgical.*) See KNEE APPARATUS, where a diversity of devices are referred to; including those for curvature, deformity, reduction, straightening, etc.

Fig. 1511.



Knee-joint Apparatus.

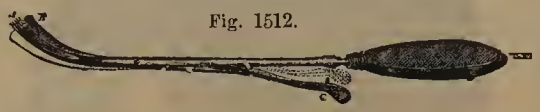
Dr. Hooper's knee-joint apparatus, shown in Fig. 1511, is an extension device to prevent the articulating surfaces from coming in contact, pending the suppression of inflammation of the parts. To prevent false anchylosis of the joint flexion is permitted. The loss of extension during flexion is overcome by placing a helix spring in curved tubes fastened on each side of the instrument shown, three inches below the joint. At the same distance above the joint are fixed rods, curved to the same arc as the tubes. The free ends of the rods fit into the tubes and rest upon the upper end of the springs By this arrangement extension is increased by flexion. The play of the joint al-

lows the limb to be flexed at right angles. The action of the spring ceases when the limb is extended to its utmost, thereby preventing any undue pressure upon the joint in a direction contrary to the one in which it should be applied.

Knick'er-boc'ker. (*Fabric.*) A French all-wool goods, with irregular spots of different colors and materials.

Knife. A cutting implement wielded by the hand, and known by name indicative of material, shape, purpose, or mode of using.

Fig. 1512.



Knife and Tenaculum.

The following list includes many which are defined or illustrated under their alphabetical heads. See, also, list of 144 knives on p. 1233, "*Mech. Dict.*"

Bait knife.
Bait-mill knife.
Blubber knife.
Boarding knife.
Boat knife.
Border knife.
Bread knife.
Bush hook.
Butter knife.
Cane knife.
Carver.
Cheek knife.
Cheese knife.
Chopping knife.
Cigar knife.
Clam knife.
Corn hook.
Corn knife.
Currier's knife.
Drawing knife.
Fatting knife.
Filling knife.
Finning knife.
Fish knife.
Fistula knife.
Flaying knife.
Flesher.
Fleshing knife.
Flitching knife.
Fruit knife.
Gilder's knife.
Hacking knife.
Hay knife.
Heading knife.
Head knife.
Hemp knife.
Herniatome.
Honey knife.
Hunter's knife.
Kitchen knife.
Lacing cutter.
Lancet.
Lemon knife.
Machete.
Mackerel knife.
Mackerel p'ow.
Microtome.
Mincing knife.
Moon knife.
Net-maker's knife.
Oyster knife.
Pallet knife.
Peat knife.
Pocket knife.
Pruning knife.
Putty knife.
Razor.
Ripping knife.
Round moon knife.
Scaling knife.
Scalpel.
Scraper.
Section knife.
Sheath knife.
Shoe knife.
Short-hair knife.
Skinning knife.
Slicer.
Slivering knife.
Spatula.
Splitting knife.
Sticking knife.
Straw knife.
Tanner's knife.
Throating knife.
Tracheatome.
Urethratome.
Uvulatome.
Valentine knife.
Whaleman's knife.

(*Surgical.*) The cutting implement has many uses and specific names in surgery. They will be found under specific heads herein and in the "*Mech. Dict.*" See list of knives, p. 1233, *Ibid.*

The *dissecting* knife is made of various shapes for the more ready separation of the parts of animal and vegetable tissues.

The *section* knife is either a flat knife for slicing thin sections of various soft tissues, for microscopic purposes, or *Valentine's* knife, which has two parallel blades for cutting out a thin section at a single stroke.

Fig. 1512 is Dr. Skene's knife and tenaculum for uterine operations.

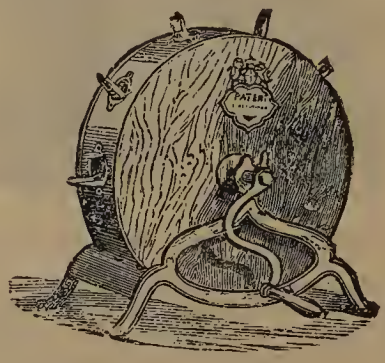
Knife Clean'er. An implement for removing stains from and polishing table-knives.

Two forms are shown in Figs. 1513, 1514. In the former the knife-blade is passed between two elastic rollers which have the abradant upon them. In the latter, the knife-blades are thrust into holes in the periphery of a round box, and are rubbed between the faces of two adjacent disks revolving in opposite directions, the distance between them being regulatable.

Fig. 1513.

Knife Cleaner.

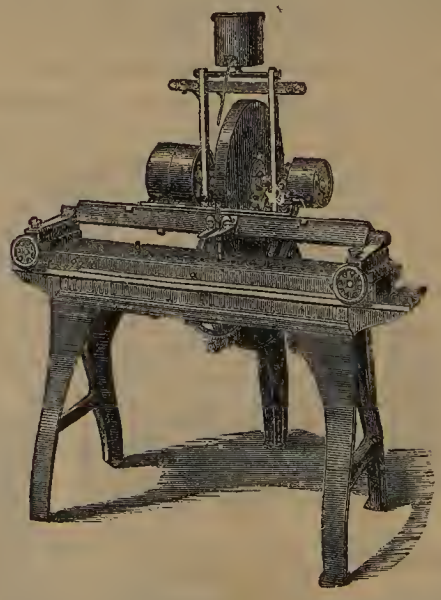
Fig. 1514.



Knife Cleaner.

Knife-grind'ing Ma-chine'. An emery wheel mounted on a bench with a way upon which the knife carriage is automatically traversed in front of the grinding wheel. Water is supplied from a trickling cup above.

Fig. 1515.



Automatic Knife-sharpening Machine.

See grinder, automatic . * "*Scientific Amer.*," xxxviii. 371.
Grinding machine . . * "*Scientific American*," xxxv. 367.
Manufacture . . . . * "*Scientific American*," xxxvii. 88.
Polishing mach., *Chase* * "*Scientific American*," xliii. 403.
Knife and tape line.
Hastings . . . . . * "*Scientific American*," xxxv. 194.

Knife Guard. (*Cutlery.*) A pivoted piece on the back of a carving fork, to protect the hand should the knife slip in carving.

The guard is combined with a rest in the carver of the *Meriden Cutlery Co.*

Knife Head. That piece in the cutting apparatus of a harvester, to which the knife is fastened, and to which the pitman-head is connected. In the Harrison knife-head, rubber buffers are placed on each side of the pitman wrist, to take up the jar and keep the eye from being battered.

Knife Rest. A bench for holding a knife while being ground or filed. Such are used in connection with grindstones and emery wheels. See under the various heads and references *passim*. Also list under GRINDING.

The rest for harvester-knives, shown in Fig. 1516, is fold-

Fig. 1516.

Harvester Knife Rest.

ing, portable, and has a box for files. It has thumb-screws for holding the knife steady.

Knit'ting Ma-chine'. Considered at length, * pp. 1234–1238, "*Mech. Dict.*"

G. W. Gregory's Report on Knitting Machines, "*Centennial Exhibition Reports*," vol. vii., Group XX., p. 53 *et seq.*, describes the following: —

Lamb	p. 53.
Campbell & Clute	p. 55.
Dana & Bickford	p. 56.
Franz & Pope	p. 56.
Hawley & Bronson	p. 56.
Tuttle	p. 57.
Gunison & Coltman	p. 58.

See also machine for jackets. * "*Engineer*," xli. 391.

Gunison & Coltman . . . * "*Scientific Amer. Sup.*," 431.

Tuttle . . . . . * "*Sc. American*," xxxvii. 383.

See also, DARNING MACHINE, *supra*.

Knock'ing. (*Add.*) 2. A jar produced by "lost motion" in the connecting parts of machinery in motion, particularly in connecting-rod bearings or brasses, in the shaft bearing or boxes, etc.

See article with diagram, "*Scientific American Supplement*," pp. 1, 17.

Knock'-knee Brace. (*Surgical.*) A supporter, to correct inward curvature of the knees. A GENU VALGUM BRACE.

Knot.

See Artificer's knot.	Lark's head.
Bend.	Lashing knot.
Boat knot.	Loop knot.
Bowline knot.	Marlinspike hitch.
Bowline on a bight.	Matthew Walker knot.
Builder's knot.	Midshipman's hitch.
Capstan knot.	Overhand knot.
Carrick bend.	Prolonge knot.
Clove hitch.	Reef knot.
Diamond knot.	Rosette.
Dog shank.	Sheepshanks.
Double knot.	Shortening knot.
English knot.	Shroud knot.
Figure-of-8 knot.	Sixfold knot.
Flemish knot.	Spritsail sheet knot.
Galley knot.	Tack knot.
Half hitch.	Twist knot.
Harness hitch.	Wall and crown.
Hawser bend.	Wall knot.
Hitch.	Weaver's knot.

Knot Ty'er. (*Surgical.*) An instrument for tying a ligature in a deep-seated situation.

See LIGATURE INSTRUMENTS, Fig. 2944, p. 1308, "*Mech. Dict.*"

Knurl'ing Tool. A tool to produce knurl work; such as that on the edge of a thumb-screw.

* "*Scientific American*," xl. 223, Fig. 2; Figs. 16–21, p. 223.

Kuft Work. (*Fine Art Metal-work.*) The name for the damasceening of Hyderabad: gold or silver wire let into undercut graved lines on a steel, iron, or bronze object, and incorporated by hammering.

A cheap *Kuft* work — a sham in fact — has gold leaf laid on a surface roughened by etching, while the gold wipes off the smoother surface.

Ky'ak. The Eskimo canoe, used in hunting and fishing.

Kys'to-tome. (*Surgical.*) See CYSTOTOME, "*Mech. Dict.*"

L.

L. A rectangularly bent pipe connection.

An *ell*. See BEND, *c. d*, Fig. 295, p. 97, *supra*.

La'bel-ing Ma-chine'. A machine for attaching labels to cans, bottles, boxes, packages, etc. See Fig. 2781, p. 1242, "*Mech. Dict.*"

Bigelow's machine is adapted to labeling round cans and is adjustable to those of any circumference and length. The labels are applied either with marginal paste, or paste all over their backs. It is operated by two persons, one to lay the can on at one end and the other to take it off at the other end; the weight and velocity of the can passing down the inclined chute doing the work. Capacity, 40 per minute.

In *Russell's* machine the paste is applied all over the back of the label, the process is automatic, the cans being simply put in and taken out; the motion is by hand crank.

La'bel Ma-chine'. A machine for preparing and printing labels.

In *Hutchinson's* label machine, Fig. 1517, the ribbon of paper is wound upon reel *B*, from which it is drawn by a regular motion of the feed-rollers *J*. The guides *C C* steady it, in its onward course, in a direct line. The rollers *D* flange it and crease it. The guide d^1 turns the flange d^2 up at right angles. The reel e^1 has on it the tape e^4. In using the tape, carry one end down under guide e^6, through the mucilage *e*, up through scraper e^5, down again under roller *G*, then under guide g^1, where it is pressed down to the paper; and, as it passes forward, the flanged edge is folded down over it by the folder *H* and is pressed firmly down by spring presser-bar *h*. It then passes between feed-rollers *J*, and on between the plate *V* and stop s^1, and the hole is punched. At the proper interval of time, the inking-roller *N* passes under the type m^1, and recedes again. The type descends with the knife and prints the tag, and the knife *L* cuts off the tag complete. A piece of strong paper strips may be used instead of the tape, or the flanged edge may be gummed, without any tape being used; or a ribbon of paper and cloth, combined in one article, may be used instead of the paper ribbon.

Lab'o-ra-to-ry Forge. A compact form of forge for the work room.

That shown in Fig. 1518 is a French form, and has bellows, hearth, vise, and drilling arrangement.

See also CHEMIST'S FORGE, Fig. 610, p. 193, *supra*, etc.

Laboratory equipment, *Schacht* * "*Sc. Amer. Sup.*," 1578.
Laboratory furnace . . . . * "*Sc. American Sup.*," 319.

Lab'o-ra-to-ry Fur'nace. A compact form of furnace for the work-shop.

For instances, see BLAST GAS FURNACE, Figs. 321–323, p. 105; BUNSEN BURNER FURNACE, Figs. 473–475, pp. 146, 147; CRUCIBLE FURNACE, Fig. 738, p. 283, *supra*, also p. 1242, "*Mech. Dict.*"

Lab'o-ra-to-ry Lathe. A form of lathe for dentists, jewelers, etc. Adapted for drilling and polishing.

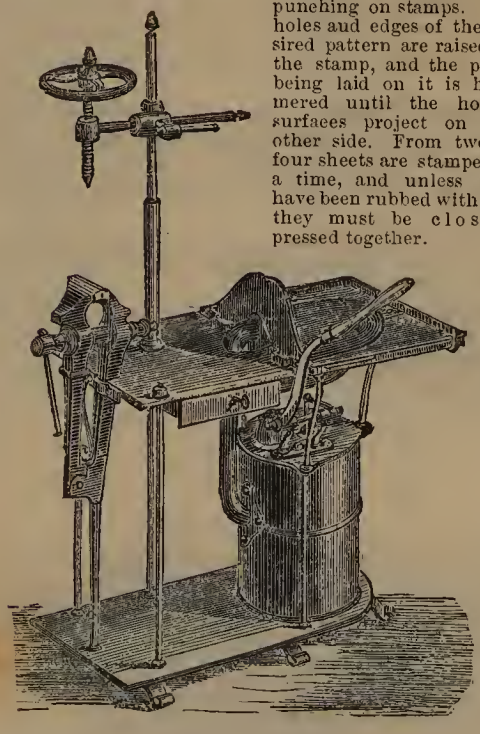
It is foot-power, stands on a tripod, and the head is thrown forward 5″ from the perpendicular to allow a person to sit while using it. The height of the head is adjustable.

Lab'y-rinth. (*Metallurgy.*) An apparatus in which the slimes or finely stamped metallic matters and gangue are placed in an extended trough exposed to a current of water. The bottom of the trough has little trenches formed by slats, and the matters deposit according to relative fineness and levity, the lighter at the greater distance from the point of ingress.

Lace Paper. Paper surface-stamped and perforated to resemble lace.

The difficulty in manufacturing these papers is to produce a surface which will exhibit, as in real lace, the fine gradations of lines. Small leaden hammers are used for punching on stamps. The holes and edges of the desired pattern are raised on the stamp, and the paper being laid on it is hammered until the hollow surfaces project on the other side. From two to four sheets are stamped at a time, and unless they have been rubbed with talc they must be closely pressed together.

Fig. 1518.



Laboratory Forge.

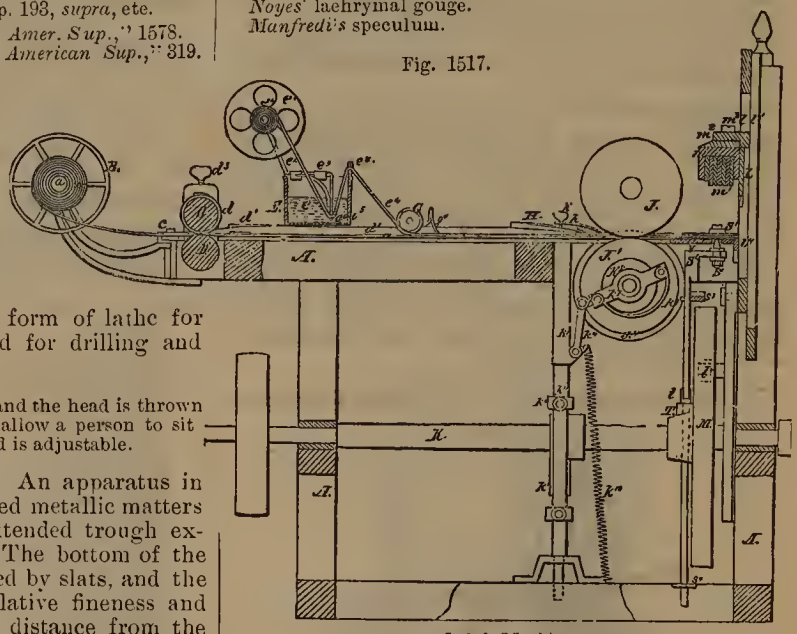
Lach'ry-mal Duct In'stru-ments. (*Surgical.*) These include syringes, dilators, probes, forceps, gouges, catheters, specula, knives.

See CANALICULA, also LACHRYMAL DUCT DILATOR, p. 1244, "*Mech. Dict.*"

See also pp. 6, 7, Part II., *Tiemann's* "*Armamentarium Chirurgicum*," for —

Anel's, *McFarland's*, *Liebold's*, *Agnew's* eye syringes.
Galezowsky's, *Weber's* canalicula dilators.
Anel's, *Bowman's*, *Williams's*, *Liebreich's*, *Levi's*, probes.
Liebreich's fistula knife.
Noyes' lachrymal gouge.
Manfredi's speculum.

Fig. 1517.



Label Machine.

Noyes' conjunctiva forceps.
Speirs' lachrymal catheter.

La'cing. (*Nautical.*) A cord to lace a sail to a gaff, or a bonnet to a sail.

La'cing Cut'ter. (*Leather.*) A knife with a gage, to preserve the width of the strip.

Lacing cutter, *Elliott* . * "*Scientific American*," xliii. 178.

La'cing Hook. (*Boot.*) Hooks on the margins of the upper, over which a lace is caught side by side alternately to close the opening in the shoe.

Fig. 1519.

Laboratory Lathe.

Lac'quer. From *lac* (*Hindu*), "the hundred thousand," alluding to the smallness of the insect, *Coccus lacca*, which produces the resinous exudation on certain Indian trees.

The Japanese lacquer, *urushi*, is from the sap of the *rhus vernicifera*, which is obtained by a process of tapping, similar to that employed in obtaining turpentine. The process is described and illustrated in the author's article on the subject in the "*Atlantic Monthly*," * vol. xl., p. 559, *et seq.* See also digest from report of Japanese Commissioners at Centennial Exhibition, 1876, in "*Scientific American*," xxxv. 89; and "*Scientific American Supplement*," 676.

The lacquer work of Japan is admittedly superior to that of China, which is attributed to the advantage possessed by the former in having a moister climate, and to the comparative absence of dust in the atmosphere. The Japanese lacquer itself is, however, more limpid than that of China, the latter having a yellow tinge.

The perfection of the Japanese and Chinese lacquer work does not altogether depend upon the excellence of the varnish or the preparation of the colors. The most elaborate pains are previously taken with

the surface of the material to be embellished. The surface of the wood is carefully smoothed; joints, if any exist, are filled with fine tow, aud covered with thin strips of silk or paper; the surface is theu auointed with a vegetable oil, found in the mountains; when dry, the varnish is applied. On this surface the gold or silver ornameutation or relief work is applied, aud the whole covered with auother coat of varnish.

Recipes: —

For Brass Castings:	Seed lac	6 oz.
	Amber of copal	2 oz.
	Dragon's blood	40 grains,
	Extract red saudal wood	30 grains.
	Oriental saffron	36 graius.
	Pounded glass	4 oz.
	Alcohol	44 oz.

Expose articles to a gentle heat and dip in the lacquer, several times if necessary. Has a good color, is durable, may be cleaned with water and dry rag.

Gold Color Lacquer:	Copal	2
	Shellac	1
Melt and add:	boiled oil	2
Mix gradually in oil turpentine		10

Color with gum guttæ in turpentine for yellow; dragon's blood for red.

For Brass or Bronze:	Shellac	16
	Dragon's blood	4
	Turmeric root	1
	Alcohol	332

Warm the article before applying.

Black Lacquer:	Shellac	9
	Methylic alcohol	50
Digest, and then apply	asphaltum	10
Dissolve in benzine		50
Lamp-black, *ad lib.*		

Dilute with alcohol and benzine.

See also BRASS LACQUERING, p. 130, *supra.*

Lacquer, Japanese . . "*Sc. Amer. Sup.*," 1831, 2756.
Paiutiug, Japanese . . * "*Iron Age*," xvii., Feb. 3, p. 7; April 6, p. 1.
Ware, Japanese . . . "*Van Nostrand's Mag.*," xiv. 364.

Lac'to-den-sim'e-ter. A specific gravity instrument by Quevenne.

It is of the hydrometer form, and has one spindle with two scales, — one to show the density of pure milk, another for skimmed milk; both scales expressing the specific gravity of the milk.

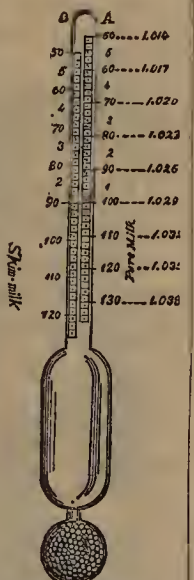
The greatest density of cow's milk is 1.035, produced under favorable circumstances. The usual density of pure good milk is 1.030, water being 1.000. A scale of 35° shows, therefore, the full range between water and the best milk, and serves to register all the information which a trial of the density can elicit.

See LACTOMETER.

Lac-tom'e-ter. An instrument for testing milk.

It is usually on the principle of the hydrometer, and determines the specific gravity.

Fig. 1520.



Centesimal Galactometer.

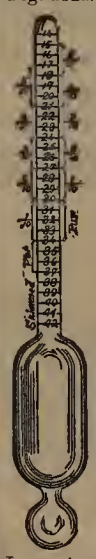
The centesimal galactometer is the invention of *Dinocourt*. It has two scales: one for pure milk, and colored yellow on the staff of the instrument; the other for skimmed milk, colored blue on the instrument.

"The first degree on the top of the scale is marked 50, which corresponds to the sp. gr. 1 014. The marks following extend from 50 to 100 (sp. gr. 1.029), and over. Each degree starting from 100, in mounting up to 50, represents a hundredth of pure milk; the degrees formed by a *line* are equal, as 50, 52, 54, etc.; the degrees formed by a dot are unequal, as 81, 83, 85, etc. To illustrate by an example: If the galactometer is sunk to the 85th degree, that will indicate 85 hundredths of pure milk, and consequently that 15 hundredths of water has been added to this milk; if sunk to 60°, that will indicate 40 hundredths of water, or four-tenths of water added.

"The skim-milk scale is, like the first, divided into hundredths (100°), of which the first 50 have been cut off as useless, as in the case of the other scale, each degree commencing from 100 to 50, and mounting upwards represents a hundredth of pure skimmed milk, consequently the manner of estimating the quantity of water added to skim milk is absolutely the same as for pure milk with cream." — "*Mott.*"

The instrument of *Bouchardat & Quevenne* is shown in Fig. 1521. It differs from that of *Dinocourt* in the division of its scale. The shaft bears three graduations.

Fig. 1521.



Lacto-densimeter.

Fig. 1522

Board of Health (N. Y.) Lactometer.

The middle one comprises the figures betweeu 14 and 42, answering to 1.014 and 1.042 specific gravity. For instance, if the iustrument be sunk in a liquid up to the figure 29, this signifies that a liter of this milk weighs 1.029 grams, and that its density is conscquently 1.029. The instrument has been graduated for the temperature of +15° C. The scale on the right is employed when it is certain that the milk acted on is not skimmed. This scale shows what are the variations of the density of milk in proportion as water is added, and the figures .1, .2, etc., indicate that the liquid operated upon has been mixed with this proportion of water. The scale on the left contains the same indications relative to skimmed milk. Milk is marked pure on this instrument, between the specific gravities 1.030 and 1.034; skimmed milk is marked pure between the gravities 1.034 and 1.037.

In graduating the Board of Health lactometer, shown in Fig. 1522, the 100° is placed at the standard 1.029, and 0 at 1.000, the gravity of water, the interuediate spaces being divided into 100 equal divisions. The point to which the lactometer sinks in the milk under examination indicates the percentage of milk in 100 parts. Thus, if the lactometer sinks to 80, the milk must consist of, at least, 20 per cent. of water and 80 of milk. This assumes the origiual milk to have had a specific gravity of 1.029; but if the milk had originally a gravity of 1.034, it would require 16.67 per cent. of water to bring it down to 1.029, and 20 per cent more water to lower it to 80° on the lactomcter. The temperature at which examiuations are made with the lactometer should be 60 F.

The following is the rapid method of chemical analysis of milk, devised by Prof. Lehmann, of Munich.

A weighed quantity, say 9 or 10 grams of milk, is diluted with an equal weight of water, and poured out in a thin layer upon a porous plate of burnt clay, very deuse and fine-grained. The water of the milk, as well as the milk sugar, albumen, and a portion of the salts dissolved in it, are absorbed by the clay plate, while the total amount of fats and caseine in the milk remain on the plate in the form of a thin skin or film. This film is easily removed with a horn spatula, and then dried and weighed. If it is desired to determine the fats alone, this film may be extracted with etber, and thus the two most important constituents of milk very quickly determined. In many cases it is sufficient to know the total weight of the principal solid constituents of the milk, hence also the amount of water, for which scarcely two hours are required. This method also possesses the advantage that a great number of samples can be tested at once without much trouble. It also does away with the use of numerous costly platinum dishes and troublesome water baths, which are always getting dry if not carefully watched. The operation is so simple that it can be used by any persou who possesses an accurate balance and set of weights.

Comparing the milk of the cow, uare, and sow by composition, the latter is found very much the richest, as the following analyses show: —

	Cow.	Mare.	Sow.
Water	87.00	90.310	81.760
Fats	4.00	1.0?5	5.830
Albuminoids	4.10	1.953	6.180
Sugar	4.28	6.285	5.335
Miueral matter	0.62	0.397	0.895
	100.00	100.000	100.000

Rich as sow's milk is, it is remarkable that the lactometer shows no cream. Drying on the water-bath, it exhales the odor of roast pork, and on putrefying, that of putrid bacon.

See *Horsley*	"*Technologiste*," xxxviii. 172.
	* "*Scientific American*," xxxiv. 203.
Banks-Schubler . . .	*Laboulaye's* "*Dictionnaire, etc.*," ii., *cap.*, "*Lait.*"
Lactoscope, *Huesner* .	"*Scientific American*," xxxvi. 21; xxxvii. 244.
Paper by *Dr. Mott* . .	* "*Sc. Am. Sup.*," 1050, 1131.
And analysis	"*Scientific American*," xxxiv. 3.

Refer to "*Jour. Phar. et Chem.*," 3d series, 1844, t. v. p. 137; "*Jour. Chem. Medic.*," 4th series, 1856, t. 11, p. 342–401.

See "*Dic. Ency. Sci. Med.*," p. 144 — Lait.

"*Répertoire de Pharmacie*," Juillet, 1856.

Tilloch's "*Philosophical Magazine*," Nos. 57, 58, p. 241.

See also PIOSCOPE.

Lac'to-scope. The lactoscope of Dr. Heusner of Barman is based on the opacity of pure milk.

It consists of two round plates of glass about the size of a watch crystal, placed parallel and held about $\frac{1}{8}''$ apart by a metal strip, which passes between them, dividing the space between them into two sections. In the lower section is placed and secured some pure milk, or, better, some permanent white fluid of precisely the same opacity as pure milk. On one of the glass plates are some fine black lines. The upper section is filled with the milk to be tested, and secured by an elastic band. On holding the apparatus between the eye and the light, the black lines being on the side opposite the eye, the black lines will be seen more distinctly through the less opaque medium. If the milk to be tested is less opaque than the normal liquid, as shown by the lines being more distinctly visible through it, the milk has probably been watered or skimmed.

Compare DIAPHONOMETER, p. 255, *supra*.

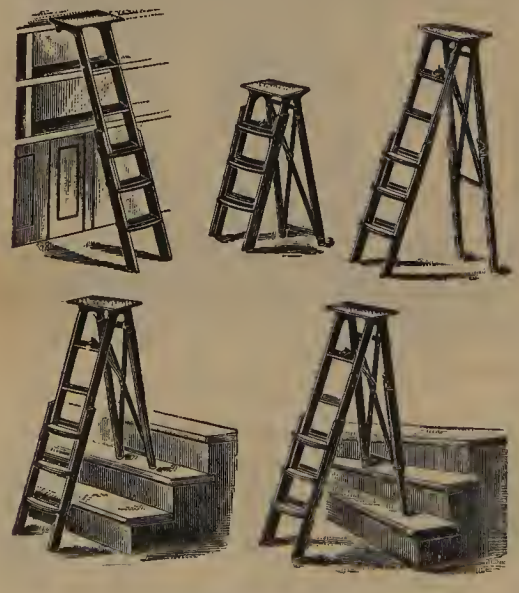
Lac Work. A very extensive industry in India. There are many styles: —

The surface of furniture, boxes, or trinquetry are covered with the lac, and this is laid on in colors, and the designs cut through to expose lower colors.

The surface thus prepared is etched or painted.

A drab ground, ornamented with geometrical flower forms, in colors.

Fig. 1523.



Protean Step-ladder.

These are but a few. The subject may be pursued in *Dr. George C. M. Birdwood's* "*Handbook to the British Indian Section.*" Paris, 1878; pp. 73, 74, 1st ed.

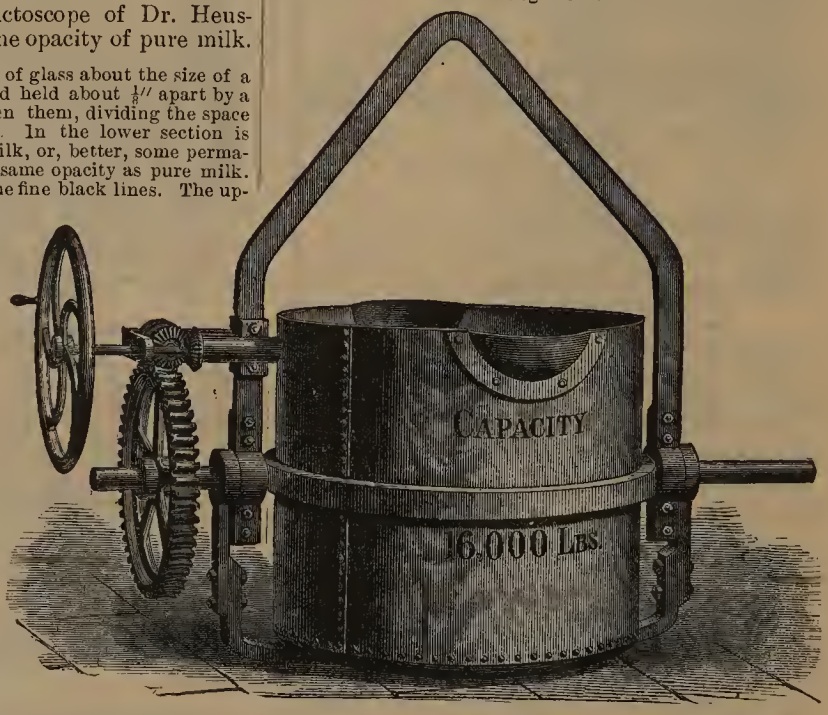
Lad'der. A portable frame with steps. A list is given on p. 1244, "*Mech. Dict.*"

A protean step-ladder is shown in Fig. 1523. It is shown closed, extended, on stairs, on winding stairs, etc —*Covert.*

Lad'der Truck. A vehicle for carrying fire-ladders and hooks. A hook-and-ladder truck. Furnished with (say) 5 ladders, 6 hand hooks, 2 axes, 2 picks, 4 lauterns, rope-reel, drag-rope, and side-ropes, etc.

La'dle. (*Founding.*) A pan or kettle with a handle, to hold molten metal for pouring.

Fig. 1524.



Balanced Foundry Ladle.

The smaller are known as bullet or plumber's ladles, etc.; the larger, as *shanks*. The glass ladle is a *cuvette*.

Fig. 1524 shows a balanced foundry label of large size, with a capacity up to 8 tons. It pours from either side, and is tipped by gearing from the hand-wheel. It is slung by the bail above from the chain of the crane, and turns on pivots.

A nickel-plated concave disk may be attached to the handle of a foundry ladle to protect the workman from heat and reflect light upon the mouth of the flask.

La'dle Fur'nace. A gas furnace in which the metal to be melted is contained in a ladle over the Bunsen jet. Its capacity is (say) ladles of 6″ diameter, to melt 6 or 8 pounds of zinc, tin, lead, etc. See Fig. 1525.

Lag'ging. (*Mining.*) The timber over and upon the sides of a drift.

Lag Screw. An iron screw, driven by a wrench, but screwing into wood; securing lagging around a cylinder or other object. See Fig. 1526.

It has a square or hexagonal head, a wood screw-thread cut on it, and is round under the head.

Lake. A precipitate of hydrate of alumina, formed in a solution containing an organic coloring matter: as *madder* lake; *cochineal* lake, etc.

Fig. 1525.

Ladle Furnace.

Fig. 1526.

Lag Screw.

Yellow lakes for dyes are produced from quercitron bark, yellow berries, yellow wood and aunatto.

Blue lakes are furnished by litmus derived from lichens found in Southern Europe, Africa, South America, and the East Indies, and indigo.

Red and violet lakes are obtained from cochineal, madder, Brazil wood, lac dye, and safflower.

Lam'i-na-ted Beam. One of the methods of forming a curved beam. They are as follows: —

The *Scarfed,*	*Flitched,*
Bent,	*Laminated.*

The latter is made of thin planks or boards, bent to shape, laid together and secured to form an integral beam, as in Figs. 312–316, pp. 138–139, "*Mech. Dict.*"

Lamp. A device in which a liquid oil or grease is burned in a wick.

Kendall's hydrostatic safety lamp is shown in Fig. 1527. The water is shown by horizontal shading, the oil by oblique. The water forms a seal for the oil, and forces the latter up the wick tube.

Lavendar's steam lamp (Br.) for collieries consists of a glass lantern 18″ square, with a funnel 24″ high. Into this is introduced a jet of steam, about 1-16″ in diameter, the object of which is to create a partial vacuum in the lantern. The consequence is, that the surrounding air is forced through the burner of the lamp, causing almost complete combustion of the oil. A very brilliant light is thus produced, the increase in brilliancy being partly owing to the products of combustion being continuously removed and a volume of fresh air introduced. The results obtained from a 4″ wick have been calculated as equal to a light of upward of 600 sperm candles

Fig. 1527.

Hydrostatic Safety Lamp.

Fig. 1528.

Hydro-electric Light.

See *Jobard*, Fr., * *Laboulaye's* "*Dictionnaire*," etc., iv., cap. "*Éclairage*," Fig. 3518.

Zimmerman's hydro-electric self-lighting light is shown in Fig. 1528. The lamp has a Dobereiner apparatus and galvanic battery combined with any form of burner or kind of illuminating liquid.

The *Dobereiner* lamp *A* serves as the pedestal, and contains the acid, water, and zinc. The gas ascends the vertical tube *B*, passes through the valve at *C*, and escapes at an orifice just below the burner. *E* is a galvanic battery, which is normally out of action, but set in activity by pressing a knob, and has wire connecting with the hydrogen outlet near the burner, heating an electrode red-hot at the same moment that hydrogen is allowed to escape. The hydrogen is inflamed and the wick lighted by the single pressure on the knob.

Blast lamp, Br. . . .	* "*Engineer*," xlii. 309
Cleaner	"*Scientific American Sup.*," 773.
Electric, *Rapieff* . . .	* "*Teleg. Journal*," vi. 333, * 363, * 430.
Extinguisher, *Hale* . .	* "*Scientific Amer.*," xxxix. 358.
Mining, *Boesch* . . .	* "*Mining & Sc. Press*," xxxv. 41.
Safety-valve, *Lewars* .	"*Iron Age*," xx., Aug. 9, p. 11.
Self-lighting time lamp.	
Covert	* "*Scientific American*," xl. 182.
Steam lamp for collieries.	
Lavendar, Br. . . .	"*Scientific American Sup*," 764.
Wick trimmer, *Bannihr*,	* "*Scientific American*," xxxv. 131.

Dissertation on lamps. Report of Azel Ames, Jr., "*Centennial Reports*," v., Group. XIV., pp. 23-31.

Lamp'black Ap'pa-ra'tus. A black pigment obtained from the smoke of burning resin, fat, or gas. See p. 1247, "*Mech. Dict.*"

See *Mallet's* report, "*Centennial Exhibition Reports*," vol. iv., Group III.

Lamp-black apparatus, * p. 110; *Neff's*, * p. 111.

Lamp'black. United States patents on Lamp-black apparatus: —

	Number.
Chater, N.	1,358
Mini, J. G.	3,824
Clark, E.	6,001
Mortimer, C.	7,266
Griswold, G. W.	11,326
Jaeger, W. G. W.	11,331
Roth, J. A.	17,519
Child, R. S.	32,753
Lundgren, J. E.	42,257
Weisman, J.	43,444
Prenatt, A.	50,493
Millochan, A.	72,068
Perlee, R. N.	72,078
Matlack, M.	75,943
Millochan, A.	84,131
Vander Weyde, P. H.	87,382
O'Reilly, P.	91,038
Brenton, J.	95,977
Farrar, A.	96,409
Howarth, J.	131,446
Wilson, G. F.	90,327
Rogers, J.	146,951
Tait, A. H.	148,778
Bottenberg, J. H.	153,234
Farrar, A.	154,467
Neff, P., & L. S. Fales	159,440
Neff, P.	160,785-160,789
Neff, P.	162,492
Neff, P.	162,679
Neff, P.	163,027
Neff, P.	166,936

Lamp Ce-ment'. For attaching the brass collar to the glass socket on the reservoir of a petroleum lamp: —

Boil 3 parts resin with 1 part caustic soda and 5 parts water. Mix with half the weight of gypsum. It sets in 45 minutes. Zinc white, white lead, or precipitated chalk may be substituted for the gypsum, but harden more slowly.

Lamp Fur'nace. One in which a lamp — in contradistinction to a gas jet, Bunsen burner, or charcoal — is used as a means of heating.

Used in laboratories: *Griffin's* for instance ; see "*Chemical Handicraft*," * p. 123.

Lamp Jack. (*Railway.*) A hood over a lamp chimney on the roof of a car.

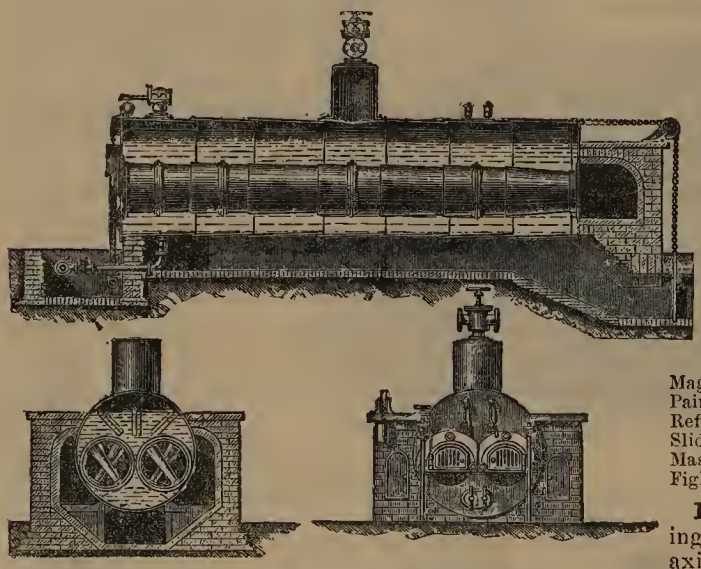
Lamp Stove. See PETROLEUM STOVE, Figs. 3364, 3365, p. 1676, "*Mech. Dict.*"

Lan'ca-shire Boil'er. The long horizontal two-flue boiler is an improvement upon the invention of the illustrious Smeaton, the originator of the flue traversing the boiler. Smeaton's boiler had a single flue; the common boiler used on our western rivers has two; but in neither case is the furnace or course of draft the same as in the Lancashire boiler, as it is called in England.

The front of each flue in the latter boiler, shown in Fig. 1529, constitutes the furnace, and the volatile products of combustion pass backward through the flues into a back chamber, revert along each side, dive under the front, and then pass underneath the length of the boiler and escape by a sub-flue to the stack.

The Cornish boiler has but a single flue and is sometimes mounted with side reverting flues ; it usually carries a lower pressure than the Lancashire boiler and is of larger diameter The Lancashire has some advantages, especially where great power is required. In large boilers, the two flue tubes form good stays for the flat ends ; the firegrates can be made of the proportions which give the greatest economy. If the

Fig. 1529.



Appleby Bros.' Lancashire Boiler. (*English.*)

flues are stoked alternately a more even temperature is maintained ; the heat in one furnace is always at its highest when the other is at its lowest, and the two flues meeting in one combustion chamber, it follows that the gases from the hottest furnace ignite and consume the thick smoke from the other which is being stoked, so that no unconsumed products need escape from the chimney.

A range of large boilers is often fitted with lifting bridges, a flue connecting the two furnaces in the front, and, after a furnace has been newly fired, the bridge is lifted by a lever in front of the boiler, and the whole of the smoke is made to pass over the fire of the other furnace. In all large works there is at least one boiler more than is required for daily use, so that any of the boilers may be laid off for periodical examination and repair when it is required.

Lance. (*Fishing.*) A fishing spear used in killing captured whales, sword-fish, porpoises, etc. For list see HARPOON.

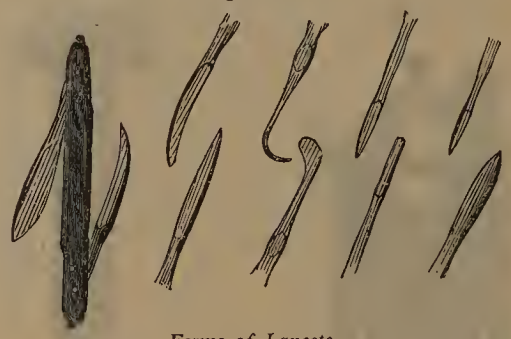
Lance Hook. (*Fishing.*) These are fastened on the boat's side to hang the lances upon.

Lan'cet. (*Surgical.*) A delicate cutting instrument which often bears a special name derived from its form or the place of its application.

Fig. 1530 shows several forms : —

Those on the left, in a handle, are a scalpel and spear bistoury.

Fig. 1530.



Forms of Lancets.

The next two are straight spear and curved probe bistouries.
The next two are a tenaculum and a gum lancet.
The next are sharp and blunt point tenotomes.
Next, tenotome and scalpel.

Land'ing Gaff. (*Fishing.*) A barbed spear for landing fish.

Land'ing Net. (*Fishing.*) A bag-net with hoop mouth for landing a hooked fish.

Land Line. (*Fishing.*) Line passing from the end of the seine to the shore.

Land Rol'ler. An implement for leveling land and breaking clods. See ROLLER. See also CLOD CRUSHER, Fig. 638, p. 201, *supra.*

Land'scape Mir'ror. A mirror which condenses or diminishes the view into a perspective effect. A *Claude Lorraine.*

Lan'tern. (*Founding.*) A perforated *core-barrel,* generally short, and of large diameter.

A portable case for protecting a light.

Miller's, *Coogan*	* "*Amer. Miller,*" vii. 167.
White . . .	* "*Iron Age,*" xix., Jan. 11. 5.
Slides	"*Sc. Am. Sup.,*" 1650, 2757.
Vertical . . .	* "*Sc. Am. Sup,*" 704, Fig. 3.
Magic lantern . .	* "*Man. & Builder,*" ix. 46.
Painting	* "*Sc. Amer.,*" xxxvii. 355.
Reflecting, *Knight* .	* "*Sc. Amer. Sup.,*" 1389.
Slides	"*Sc. Amer.,*" xxxvi. 229.
Mast-head, *Stone,* Br.	See *infra.*
Fighting, Br. . . .	Fig. 1025, p. 333, *supra.*

Lap. 1. A wheel or disk used in grinding or polishing. Usually on a vertical axis. See p. 1252, "*Mech. Dict.*"

(*Watchmaking.*) Grinding and polishing laps are made of emery, copper, tin, boxwood, ivory, and Arkansas oil stone, of various dimensions.

The various kinds of wheels, and the abradants for grinding and polishing, are mentioned on p. 1253, "*Mech. Dict.*" Their relative hardness is given in a table, p. 1617, *Ibid.*

Japanese lapidary . . "*Scientific American,*" xli. 298.

2. A fleece of wool or cotton. See LAPPING MACHINE.

Lap-doub'ling Ma-chine'. A machine which winds two fleeces of cotton upon the roller by means of two sets of rack gear and a top plain roller, which rests on two fluted calender rollers, and is lifted as the lap is formed. *Platt Bros.* (Br.)

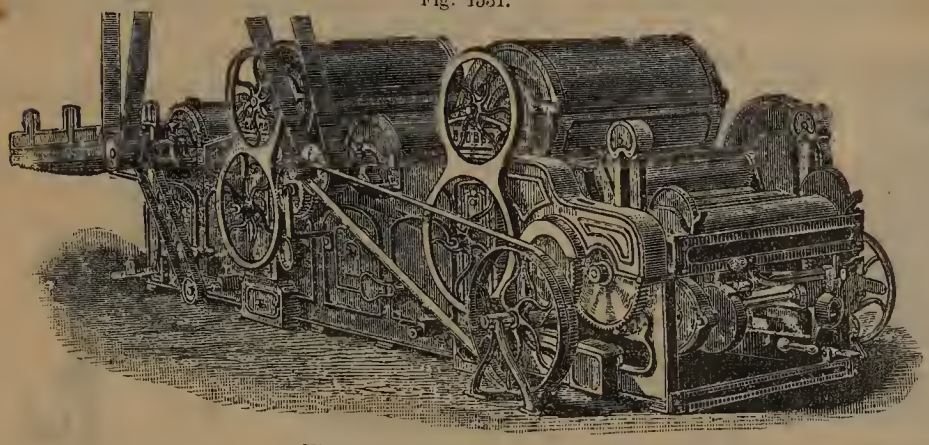
Lap Scale. A scale with a pan in which a given quantity of wool or cotton is weighed to be spread upon a given length of the traveling feeding apron of the lapper or carding machine, as the case may be.

Lap'per. Primarily, a machine for taking cotton from the opener and making it into a lap.

Fig. 1531 is a machine receiving bale cotton, to open, clean, and make it into a lap.

The machine, as shown in the figure, has in fact two open-

Fig. 1531.



Kitson Cotton Opener and Lapper.

ers, each separate and complete in itself, both delivering the cotton on to one pair of screens, when the two quantities unite and pass through the rest of the machine to form the lap. The aprons run slowly, and a draft of 12 to 1 is obtained.

A second operation may take place upon a *finisher lapper*. Clarke and Pelham's three-roll sectional evener is used on the Kitson finisher lapper to vary the speed according to the varying thickness of the cotton passing into the machine. This evener has two fluted bed-rolls above which are eight sectional rolls which are saddled in pairs. Each pair of saddles has a single saddle, and above there is one which thus bears upon the whole system beneath. In the center of the main saddle is a rack operating a pinion attached to a quadrant which communicates by a chain with the belt shipper on the concave and convex cone pulleys, so as to affect the rate of feed.

Lap Ta'ble. A sewing or cutting-out table, supported in or over the lap; a lap-board.

Lard Press. A domestic press for squeezing lard from cracklings.

A *screw-down* press is shown at Fig. 2811, p. 1255, "*Mech. Dict.*"

A *draw-up* press at Fig. 872, p. 274, *supra*.

Toggle motion, *Boomer & Boschert*, * "*Sc. Am.*," xlii. 242.

Lark's Head. (*Nautical.*) A form of bend; see 24, 25, Fig. 2777, p. 1240, "*Mech. Dict.*"

Lar'i-at Swiv'el. A coupling link for a lariat and picket pin, preventing the twisting of the rope as the animal wanders around the picket pin.

Fig. 1532.

Lariat Swivel.

Lar-yn'ge-al For'ceps. An instrument for the extraction of laryngeal tumors.

The method of using the instrument is as follows: After the vertical portion *c*, being temporarily made as short as possible, has been introduced into the larynx, it is lengthened by the lever *l* pushing both rods *t'* and *f'* into the tubular portion *b c*, which causes both the smaller tube *t* and the forceps *f* to descend. As soon as the length desired is attained, the serrated rod *f'* is arrested by pressure made on the hook-shaped projection *r'* with the thumb, causing the claws to grasp and retain it. The forceps are closed by continuance of the pressure on the lever *l*, causing the rod *t'* to push the smaller tube *t* over the base of the forceps and close them upon the tumor.

Fig. 1533.

Rumbold's Laryngeal Forceps.

Lar-yn'ge-al In'stru-ments. (*Surgical.*) This includes a number of instruments, notably: —

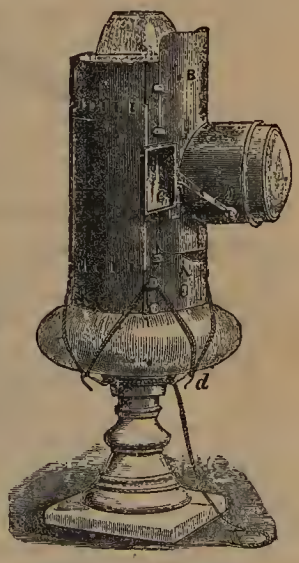
Caustic carrier.	
Powder blower.	
Scoop.	
Écraseur.	
Electrode.	
Forceps.	Lancet.
Inhaler.	Scissors.
Syringe.	Tonsilotome.
Laryngoscope.	Lanteru.
Mirror.	etc.

Lar-yn'go Phan'tom. An apparatus devised by Dr. Isenschmid, of Munich, and intended to familiarize medical students and practitioners with as many of the details connected with the use of the laryngoscope as it is possible to learn before the application of the instrument to the living subject.

The phantom consists of three parts: first, there is a mouth of thin metal, with tongue and uvula made of red velvet. This is fixed on a laryngeal tube of metal, which has a slit by which the thirty painted images of different views of, and different conditions of the laryngeal tract can be introduced. The laryngeal tube is movable on a second tube, which is tightly fixed on a peg in the middle of a small box in which the whole apparatus can be packed. The anatomical dimensions are taken from nature. When in use the phantom is placed like the head of a patient who is about to be examined, one or two feet in front of the lamp, but aside from it, so that the rays coming from the lamp and passing the right ear of the patient on to the mirror fixed at the forehead of the observer, are reflected into the mouth of the patient. — *Tiemann.*

Lar'yn-go-scop'ic Lan'tern. A light concentrated for use in laryngoscopic examination and operation.

Fig. 1534.



Laryngoscopic Lantern.

Fig. 1534 shows Dr. Oliver's, which is designed for direct light, though the frontal deflector — shown in Fig. 2815, p. 1257, "*Mech. Dict.*," may be used if desired. It is an attachment to an ordinary lamp.

The lantern is made up of three main portions — the front piece *A*, and two wings which hinge upon the front piece, and by which the diameter of the lantern may be increased to suit the diameter of the glass chimney. The wings are locked together at the desired point, as at *a a*. As the lens must be on a level with the flame, the tube containing it is attached to a slide *B*, which, moving in grooves in the front main piece, may be raised or lowered, as found necessary. The lens is also movable within the tube, in order to admit of its being retained at its focal distance from the flame, when the diameter of the lantern is changed. The movement is made by the sliding of a knob on each side, *b*, in an elongated opening in the tube. The lantern is made firm upon the

lamp by a cord. At *c* is seen the little mirror for use in auto-laryngoscopy.

La-ryn'go-stro-bo-scop'ic Ap'pa-ra'tus. A method by Dr. Oertel, of Munich, of observing the vibrations of the vocal cords during the production of sounds.

The apparatus consists of a laryngoscope mirror, a strong light, and an arraugement by which the light shall be rapidly interrupted. The effect of the interruption of the light is to prevent the impressions made by the vibrations upon the retina from being modified before they can be perceived. The interruption may be conveniently produced by means of a perforated diaphragm revolving rapidly, and at a rate proportioned to the rapidity of the vibrations of the sounding cord; or it may be by a tuning-fork of the proper note. The interrupting apparatus must be placed betweeu the light and the mirror, or behind the mirror, between it and the observer. By this means it is possible not merely to observe accurately the vibrations of one of the vocal cords, but also to compare the vibrations of one with those of another.

Lar'ynx, Ar'ti-fi'cial. A metallic instrument provided with vibratory reeds and attached to the upper surface of the tracheotomy tube. The removal of the natural larynx by dissection from the surrounding parts, and the invention and placing of the substitute were by Prof. Billroth, of Vienna.

Lash'ing. (*Nautical.*) For list of *whipping, seizing, lashing*, etc., see SEIZING.

Lash'ing Eye. (*Nautical.*) A spliced loop in the end of a rope by which it may be lashed fast to an object. Lower stays, block straps, etc., are thus fitted.

Lash'ing Knot. (*Nautical.*) A form of bend; see 31, Fig. 2777, p. 1240, "*Mech. Dict.*"

Latch. (*Fishing.*) A clamp for the inboard end of a fishing line.

Stacey, June 2, 1868 . . . . . Patent, No. 78,546.

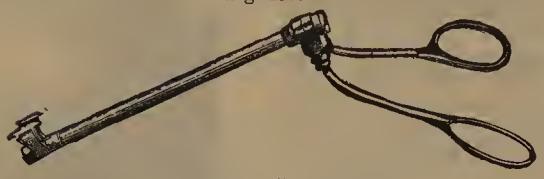
See also MACKEREL LATCH.

Lat'er-al Branch. A pipe with side connections. See several forms in Fig. 420, p. 129, *supra*.

Lat'er-al Cur'va-ture In'stru-ments. (*Surgical.*) A name applied to knock-knee and bow-leg braces, to some species of talipes instruments, wry neck, etc. See enumeration under CURVATURE APPARATUS, p. 236, *supra*.

Lat'e-ral Scis'sors. (*Surgical.*) A scissors

Fig. 1535.



Dr. Turnipseed's Lateral Scissors.

the blades of which approach like those of cutting pliers. Used in vesico-vaginal fistula, etc.

Lathe. See account and enumeration of 136 varieties, pp. 1261, 1263, "*Mech. Dict.*"

Sec also: amateur's . .	* "*Scientific American*," xxxix. 370.
Chuck, *Cushman* . . .	* "*Am. Man.*," Jan. 16, 1880, p. 12.
	* "*Scientific Amer.*," xxxviii 226.
Horton	* *Thurston's* "*Vienna Rept.*," iii. 337.
Pratt & Whitney . .	* "*Iron Age*," xxi., June 13, p. 1.
Cornell Univ. foot . .	"*Scientific American*," xxxv. 148.
Dog, *Clements*, Br. . .	* "*Railroad Gazette*," viii. 53.
Driver, *Harris*	* "*Min. & Sc. Press*," xxxiv. 361.
Driver, *Timmins*, Br. .	* "*Engineer*," xlvii. 258.
100-ton guns.	
St. Chamond . . .	"*Scientific American*," xliii. 225.
Overhead motion, *Greenwood & Batley*, Br. .	* "*Engineering*," xxvi. 16.
Scroll saw, etc., *Stevens*	* "*Scientific Amer.*," xxxvii. 374.
Sellers	* *Thurston's* "*Vienna Rept.*," ii. 209.
To test a, *Rose* . . .	"*Scientific American*," xxxix. 213.
Universal, *Koch & Miller*	* "*Scientific American Sup.*," 157.
	* "*Scientific American*," xxxvi. 118.

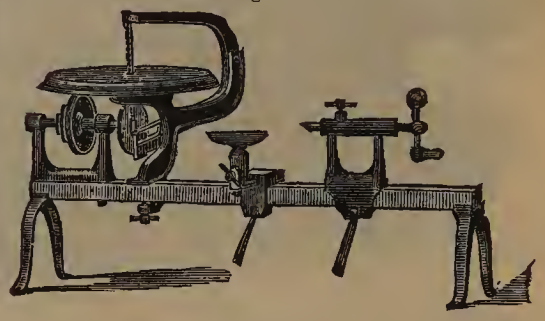
Sec *Campin's* "*The Practice of Hand Turning in Wood, Ivory, Shell, etc.*"

"*The Turner's Companion.*"

Watson's "*Manual of the Hand Lathe.*"

Lathe and Saw. A combination for light

Fig. 1536.



Lathe and Saw.

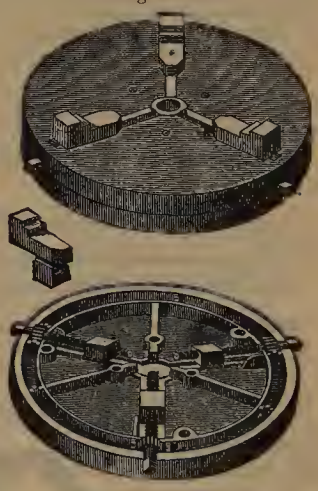
work, for amateurs and juveniles. The mandrel has a face plate with a wrist to which the lower end of the saw is attached; the upper end is connected with a spring arm.

Lathe Car'rier. A piece secured to the object in the lathe, and having a projection which collides with a stud on the face plate to cause the object to rotate in concert with the mandrel and face plate.

Fig. 1537.

Lathe Carrier.

Fig. 1538.



Inside Jaw Chuck.

Lathe Chuck. A device screwed to the mandrel of a lathe and grasping the object to be turned, bored, ground, polished, or what not.

Figs. 1538, 1539, show *Horton's* lathe chuck. The jaws are moved by geared screws and circular rack.

The circular wrought iron rack is inclosed in the deep groove or recess in the back plate, the center faces of back and front plates are then turned true, which, when bolted together, makes a tight casing for the gearing, excluding dirt, chips, etc. When the rack is taken out, it makes an independent jaw chuck. The jaws are made solid, and forged of one piece of metal, and case-hardened.

Fig. 1539.

Reverse Jaw Chuck.

Figs. 1540, 1541, show *Johnson's* universal chuck.

Fig. 1540 is a face view, and represents the chuck ready for use. Fig. 1541 has a section through the edge of the body parallel with its face, the back part being removed to

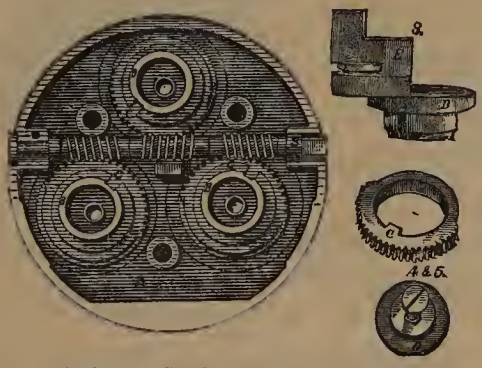
show the internal arrangement. Figs. 3, 4, 5, are details of construction; the jaw *E* revolves upon a steel piu in the arm of wheel *B*, to which it is also tongued and grooved, but

Fig. 1540.

Johnson's Universal Chuck.

which when turned to a certain position can be removed therefrom at will. The toothed ring *C* has a solid feather, and is accurately fitted and forced to its seat upon *B*. The

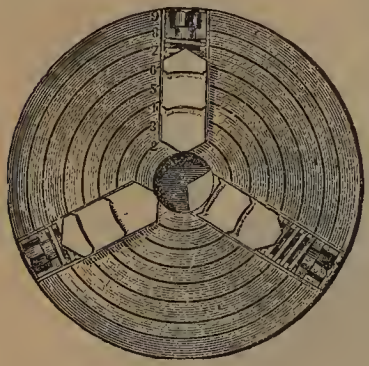
Fig. 1541.



Universal Chuck. (*Section and Details.*)

screw aud plate *D* secure *B* in place. The worm shaft *S* is of cast steel. The toothed rings *C C C*, and jaws *E E E*, are of hammered iron, aud case-hardened.

Fig. 1542.



Westcott's Lathe Chuck (*Face*).

Westcott's combination lathe chuck is shown in Figs. 1542, 1543.

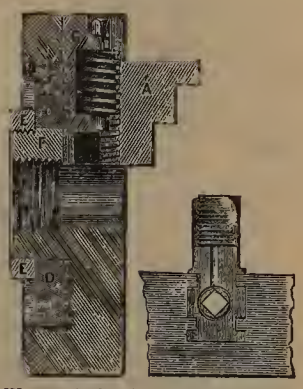
The jaws are reversible, can be made to act independently, or concentrically and simultaneously. May hold round, oval, or irregular shapes. Fig. 1542 is a face view of the chuck with one jaw reversed.

Fig. 1543 is a vertical section, showing the manner in which the ring *D* engages in box *C;* also showing the position of the screw *B*. The figure also gives a section of the chuck showing the end of the screw and box *C;* also the manner in which the parts are secured to the body of chuck.

In *Cushman's* lathe chuck, Fig. 1544, the jaws slide in radial slots in the face, and have several shoulders or steps, rising in height, and capable of reversal. One of the jaws is shown reversed in Fig. 1544. By a reversal of all the jaws small objects may be grasped, or by partial reversion irregular pieces may be grasped.

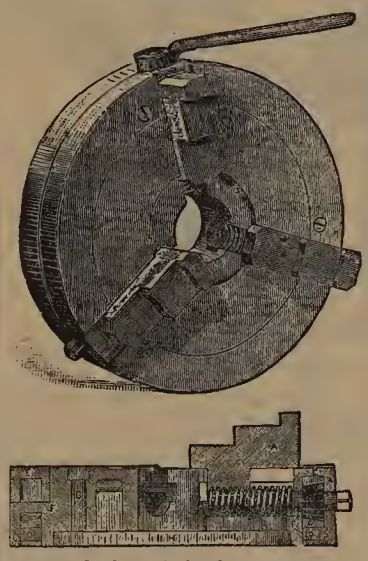
That portion of the jaws which enters the body of the chuck is cut into a half nut, *A*, that engages with a screw *B*, the square head of which projects through the face or rim of the chuck to receive a wrench. Below this projecting head is a bevel pinion inside the rim that engages with circular rack or toothed ring *C C*. Turning any one of these screws will actuate the rack and every other screw, and so far it is simply a concentric-jawed chuck. But the chuck is capable of transformation into one of eccentrically-placed jaws. The toothed ring rests upon a plain ring, *D*, *D*, the periphery of which is a screw-thread that engages with a similar thread on the inside of the shell, so that by turning the ring in one direction it is moved forward toward the face of the chuck, and by turning it the other way it is carried towards the back of the chuck. By this means the circular rack may be meshed iu gear with the pinions in the screws, or disengaged from them. Should it be required to move one or more of the jaws farther from the center than the others, the spring catch is released by thumb-pressure, the supporting ring is turned out by a knob at the back of the chuck, and the circular rack unmeshed. In this conditiou it has the characteristics of an independent jaw-chuck. Then the jaws, one or more, may be moved singly into the position required, when the circular rack and the screw pinions may be again meshed, forming a chuck with eccentrically-placed but simultaneously moving jaws.

Fig. 1543.



Westcott's Lathe Chuck (*Section*).

Fig. 1544.



Cushman's Lathe Chuck.

See also Drill Chuck, pp. 275, 276, *supra:* and Fig. 2833, p. 1263; Figs. 1287, 1288, pp. 548, 549, "*Mech. Dict.*"

Fig. 1545.

Lathe Dog.

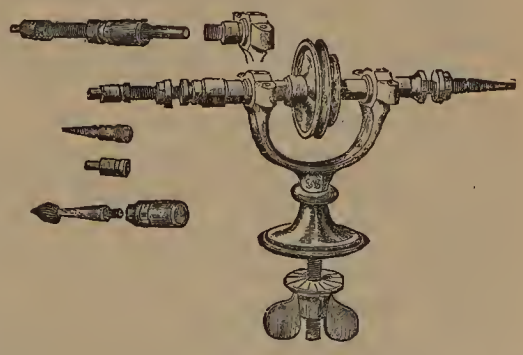
Lathe Dog. A piece to be attached to an object in a lathe to cause it to revolve with the lathe spindle. A *lathe carrier.*

See also Clamp Dog, Fig. 625, p. 198, *supra.*

Lathe Head. The working part of a jeweler's or laboratory lathe; attachable to a lathe or stand, and driven by a cord from any pedal motor.

The illustration is White's dental lathe with burs, extension pieces, cone chucks for polishing cones, etc.

Fig. 1546.



Lathe Head.

Lathe Hoist. A device to lift work to the

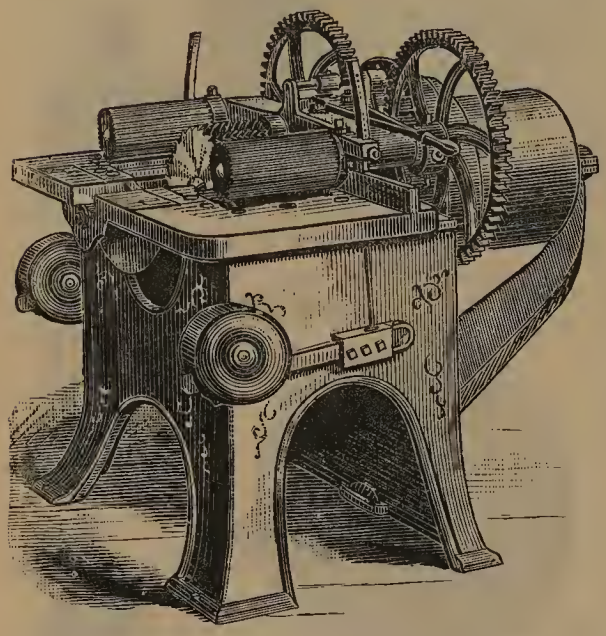
height of the lathe centers in order to be placed in the lathe.

See AXLE-LATHE HOIST, *Thomas*, * "*Railroad Gazette*," viii., p. 239.

Lath Mill. A gang-saw, for sawing lath from the bolt.

The gang of saws in *Smith's* lath mill occupies a space 10″ in width, so that in cutting ½″ lath 16 saws may be employed. Plank of any width may be passed. The feed

Fig. 1547.



Smith's Lath Mill.

works consist of four rollers which may be started or stopped at will; the two upper rollers are weighted and driven by power. The rates of feed are 35′ to 45′ per minute. To prevent the lumber from springing and binding the saws a steel comb is attached to the bed, with teeth projecting upward, directly in the rear of the saws.

In the *Leonard & Silliman* machine the annular saws are separated by rings on a cylinder keyed on to the main shaft. The interior of the cylinder has spiral wings, which make a draft, and draw away the dust.

Lathing machine, *Trimble* * "*Scientific Amer.*," xxxiv. 131.

Lat'i-mer-Clark Bat'te-ry. (*Electricity.*) A battery designed as a standard, having a perfectly constant electro-motive force.

It consists of a combination of zinc in sulphate of zinc, and mercury in sulphate of mercury.

This battery has an electro-motive force of 1.4573 volts in absolute measurement.

"*Phil. Trans. Royal Society*," June 19, 1875.
Niaudet, Am. transl., 148.

Lat'rine. A water-closet for public use; the hoppers are flushed periodically.

Jennings . . . * "*Manufacturer & Builder*," viii. 154

Lat'tice. A form of screen made of intersecting overlaid slats.

A form of girder having series of flat bars laid crosswise and riveted at the intersections, or at the junction with the upper and lower members, or both. See IRON BRIDGE, p. 120, "*Mech. Dict.*"

Launch. Formerly: the largest of the suit of boats attached to a man-of-war.

Now: a large boat with steam power.

The Thorneycroft (Br.) launches have acquired most distinction.

One of these attained at Cherbourg a speed of 19 knots per hour; and 18 knots for two consecutive hours, developing 220 horse-power. The dimensions were—

Length, 63.04′.
Beam, 8.53′.
Draft, 2′ (average).
Displacement, 15 tons.
Weight of hull, 9,900 pounds.
Weight of engine boilers and water, 16,060 pounds.
Power at speed of 18¾ knots, 220 horse.
Weight of machinery, 72.6 pounds per horse power.

The engines are condensing, two cylinder, on the compound system. The boilers are of the locomotive type, with the difference that the tubular surface is reduced about one half. This is the only sacrifice which has been made for the economic production of power; and it was necessary in order to reduce the weight of the apparatus. The safety valves are loaded to 132 lbs. The engine makes 430 revolutions per minute, which requires great mechanical excellence of the mechanism, and especially of the air-pump. The consumption of coal per horse power per hour is 3.52 lbs. The grate surface is 11.19 square feet. An artificial blast is conducted directly to the fire chamber instead of to the ash-pit.

The screw shaft is placed on a level with the keel, instead of being at a point half way between the keel and the water-line, as is usually the case. The screw then projects below the keel for nearly half its diameter, and consequently it acts upon a section of vein greater in area than the greatest section of the vessel. This arrangement doubtless contributes materially to the speed; while a sharp bend of the keel protects the propeller from damage.

Launch, steam . . . * "*Scientific American Sup.*," 2715.
For Africa, Br. . . . * "*Engineering*," xxix. 475.
Sectional for Africa . . * "*Scientific American Sup.*," 3802.
"Barrancas," . . . . * "*Scientific Amer.*," xxxviii. 371.
"Cinderella," . . . . * "*Scientific American Sup.*," 1423.
Herreshoff . . . . . "*Scientific American Sup.*," 4121.
Lewin . . . . . * "*Scientific American Sup.*," 1567
Maxim . . . . . * "*Sc. Amer. Sup.*," 1279, * 2516.
Passenger, Neva . . . * "*Engineer*," xlii. 272.
N. Y. Safety Steam Power Co. . . . . * "*Manufact. & Builder*," viii. 152.
Russian, *Crichton* . . * "*Scientific American Sup.*," 1186.

2. A slip. See MARINE SLIP, "*Mech. Dict.*"

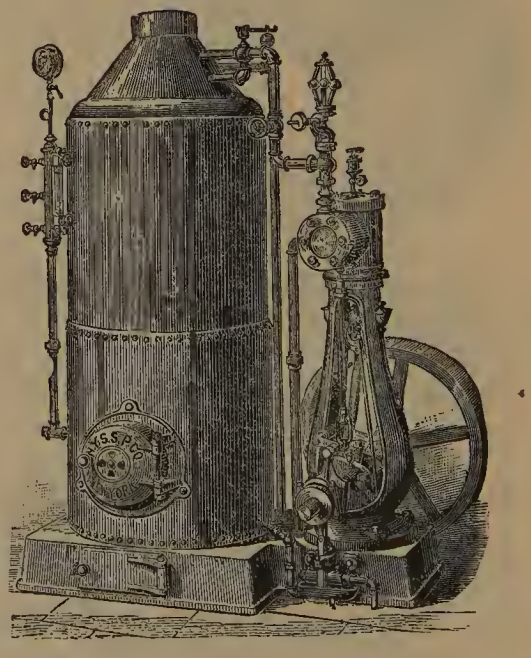
Launching slip, iron-clad Kaiser, Br. . . * "*Engineer*," xliv. 170.
Launching iron-clads . * "*Scientific American Sup.*," 1539.

Launch En'gine. A relatively small engine, for use in launches, large boats acting as tenders, police boats in harbors, etc. A small class of surveying and pleasure steamers are also called launches.

The engine and boiler of the *New York Safety Steam Power Co.* are shown in Fig. 1548, and a section of the boiler in Fig. 1549.

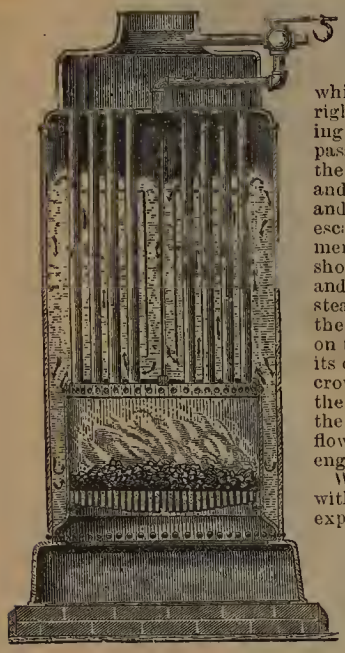
The engine is upright, having the cylinder mounted on

Fig. 1548.



Launch Engine and Boiler.

Fig. 1549.



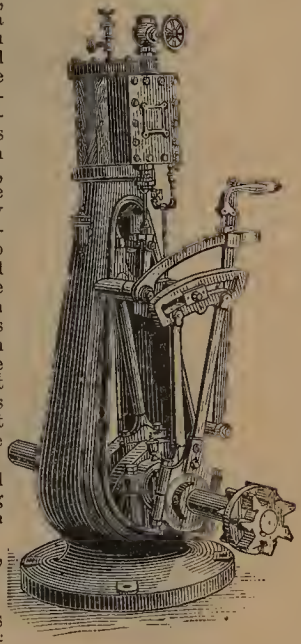
Launch Engine Boiler.

top of the bottle-shaped frame, which has two large openings at each side for access to the working parts. The fly-wheel, being at the base, secures steadiness. The engine has a plain slide-valve, and the slides are concave and cast with the frame. In Fig. 1548 the engine is shown combined with the boiler, both being placed on a cast-iron base which forms the ash-pit, and also contains the heater. An upright tubular boiler, Fig. 1549, is used, and, to prevent priming, a baffle-plate is introduced, through which all the tubes pass at or about the water-level. A large tube hangs from the center of this plate nearly to the crown of the furnace, and an annular space is left around the outside of the baffle and between it and the outer shell, sufficient for the easy escape of the steam and water. The effect of this arrangement is to stop the current of steam and water tending to shoot up between the tubes, and compel it to flow outward and escape between the baffle and shell, at which point the steam and water separate, most of the water flowing down the side of the shell, while the remainder of the water falls on the top of the baffle-plate and flows through the tube in its center, thus keeping up a current over the center of the crown sheet and among the tubes. It will be observed that the steam is taken off from the center of the boiler; and as the steam is delivered at the outer edge of the baffle it must flow inward between and around the tubes on its way to the engine and become dried and slightly superheated.

When designed for a steam launch the engine is provided with a link-motion for reversing, and notches for working expansively. The feed-pump is driven by an eccentric on the shaft.

Fig. 1550 shows the engine as detached from the boiler, and having the provisions just cited.

Fig. 1550.



Launch Engine.

Figs. 1551 to 1555 show the launch engines of a United States cutter, having a length of 33′; beam, 8′ 7″; and depth, 3′ 9½″.

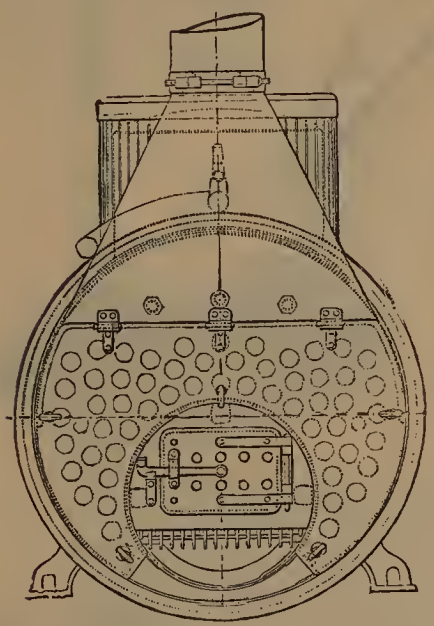
The boiler is of the ordinary multi-tubular type, and consists of a shell 3′ 4½″ in diameter outside, with a furnace 20½″ in external diameter, all the plates of the shell and furnace (including the tube-plates) being ¼″ thick. The boiler is provided with 60 return tubes 3′ 1½″ long over tube-plates, 58 of these tubes being 2″ in diameter outside and the other two 1½″ in diameter. The fire-grate area is 4.5′ square, and the total heating surface 125′ square. A dome 20″ in diameter, and 13¾″ high, is fixed at the top of the boiler, and the latter is fed by a donkey pump bolted to it at the back end. The details of the boiler and its fittings will be readily understood from the figures, and the weight of the boiler complete, as shown, is 2,350 lbs. The general arrangement of the fittings is neat.

The cylinder is 8″, stroke 10″, and the engine weighs 725 lbs., the weight being rather heavy, owing to the somewhat singular arrangement adopted to obtain a long connecting-rod, and still keep the cylinder down tolerably close to the crank-shaft. The engine has a connecting-rod 26″ — or 2.6 times the stroke — in length, and its height from center of crank-shaft to top of upper cylinder cover is 38″ or 3.8 times the stroke.

As will be seen from Fig. 1555, the piston-rod, instead of being coupled direct to the connecting-rod, is screwed into a cross-head from which a pair of side rods extend upward terminating in blocks working in guides formed at the sides of the cylinder. The connecting-rod is made with a wide fork, and takes hold of pins forged in one piece with the side rods and blocks just mentioned.

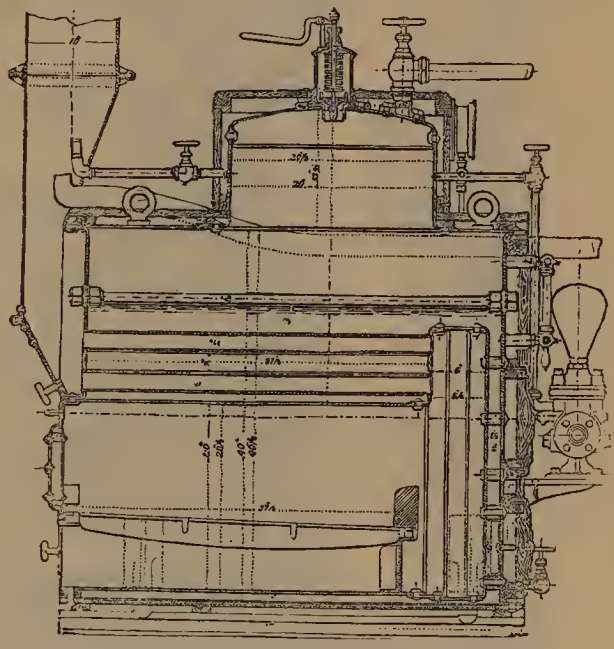
The link motion is used only for reversing and not for expansive working, the link being made with a straight slot, and provision being only made for fixing the block in extreme position by the arrangement shown. The valve is driven through the intervention of a rocking shaft and levers.

Fig. 1551.



United States Launch Engine. (Cross Section of Boiler.)

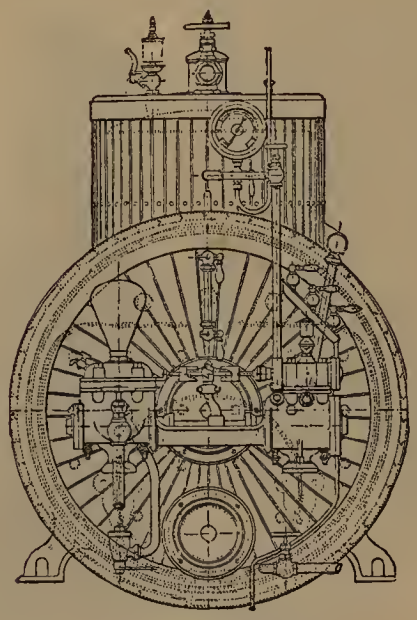
Fig. 1552.



Launch Engine. (Longitudinal Section of Boiler.)

Cf. . . . . . * "*Scientific Amer.*," xxxviii. 371.
Hayes, Br. . . . . * "*Engineer*," xlvi. 155.

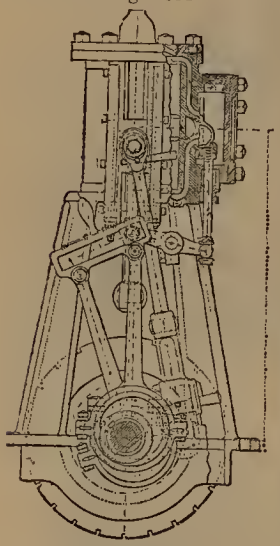
Fig. 1553.



Launch Engine. (*Elevation.*)

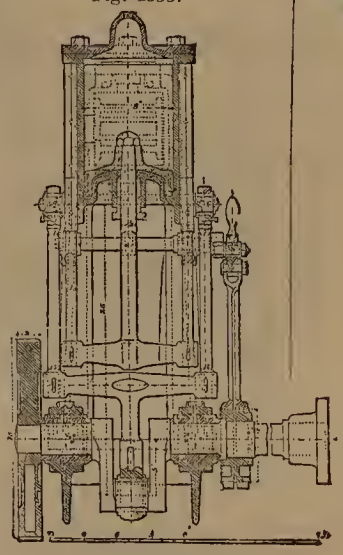
Herreshoff	* "*Engineering*," xxviii. 264.
Kingdon, Br.	* "*Engineering*," xxix. 495.
Lewin, Br.	* "*Engineer*," xliv. 267.
	* "*Sc. Am. Sup.*," 1567.
Messenger & Churchward	* "*Sc. Am. Sup.*," 1833.
N. Y. Safety Steam Power Co.	* "*Man. & B.*," viii. 152.
Outridge, Br.	* "*Engineer*," xlix. 439.
Steam, U. S.	* "*Engineering*," xxi. 436.
Wigzell & Halsey, Br	* "*Engineering*," xxiii. 16.

Fig. 1554.



Launch Engine. (*Link Motion.*)

Fig. 1555.



Launch Engine (*Section of Engine.*)

Laun'dry Ap'pa-ra'tus. Plate XXV. shows the interior of a French steam laundry with the apparatus in position and their names indicated beneath. It comprises the fittings made by Pierron & Dehaître, of Paris.

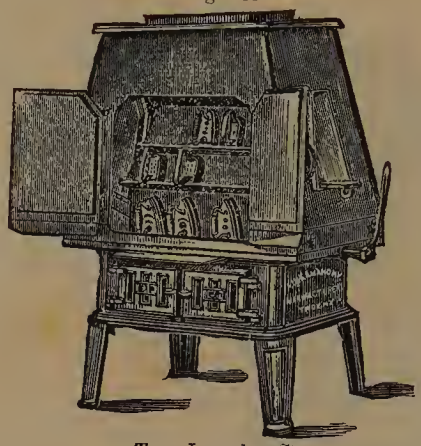
Laun'dry Boil'er. A water heater for laundry purposes. See figure in Plate XXV.; also KETTLE, *supra*.

Lav'a-to-ry. A wash-room.

Jennings . . * "*Manufacturer & Builder*," viii. 259.

Laun'dry Stove. One for heating water and smoothing irons for laundry purposes.

Fig. 1556.



Troy Laundry Stove.

The Troy laundry heater, shown in Fig. 1556, heats at one time 40 sad-irons or 80 polishing irons.

Another form has less capacity for irons, but has a large belt around it in which water is heated and whence it is conducted by pipes to the tubs.

See also IRONING STOVE, Fig. 1467, p. 506, *supra*.

Lawn Hose Cart. A small vehicle for garden and yard hose.

See HOSE REEL, Fig. 2585, p. 1132, "*Mech. Dict.*"

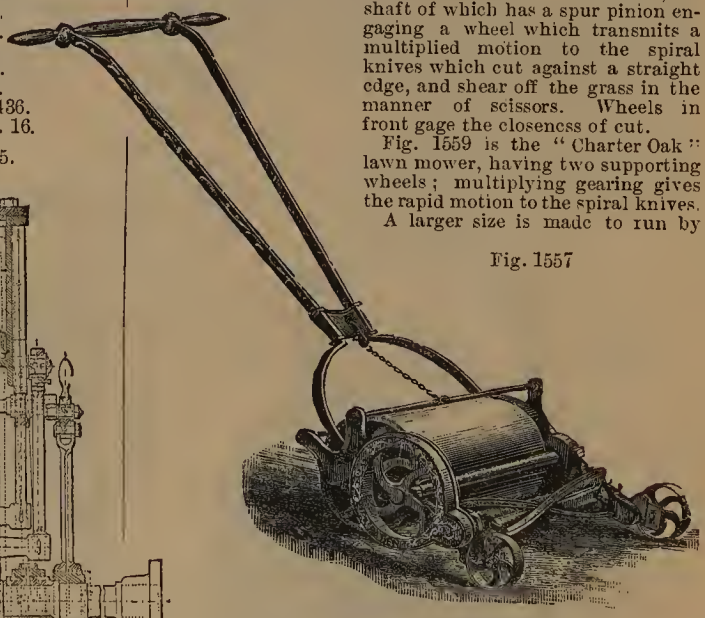
Lawn Mow'er. A machine for cutting sward.

Hill's archimedean lawn mower is mounted on a roller, the shaft of which has a spur pinion engaging a wheel which transmits a multiplied motion to the spiral knives which cut against a straight edge, and shear off the grass in the manner of scissors. Wheels in front gage the closeness of cut.

Fig. 1559 is the "Charter Oak" lawn mower, having two supporting wheels; multiplying gearing gives the rapid motion to the spiral knives.

A larger size is made to run by

Fig. 1557

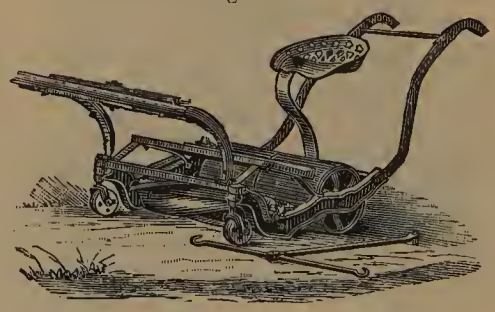


Hill's Archimedean Mower.

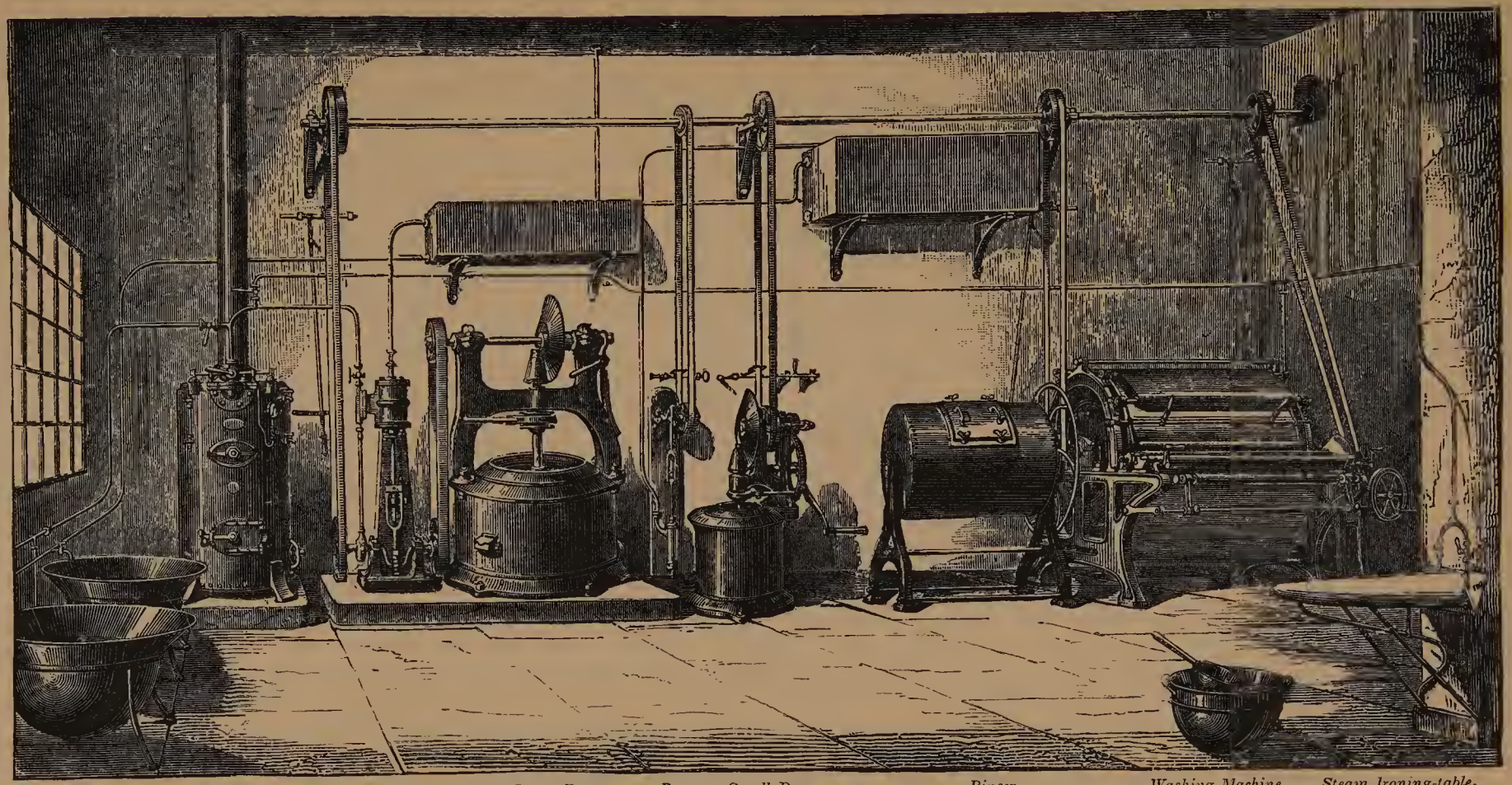
pony. Some American and British forms have capacious boxes to catch the mown grass.

Ohmer's machine has crank and reciprocating sickle.

Fig. 1558.



Pony Lawn Mower.



Kettles. *Boiler.* *Engine.* *Large Dryer.* *Pump.* *Small Dryer.* *Rinser.* *Washing Machine.* *Steam Ironing-table.*

PLATE XXV.

INTERIOR OF A FRENCH LAUNDRY.
[*Pierron et Dehaître, Paris.*]

See page 532.

Fig 1558 shows one of the larger sizes adapted to be drawn by a pony. It has a shaft and seat, also a pair of handles to be used when a seat is not desired. The cut is 30″.

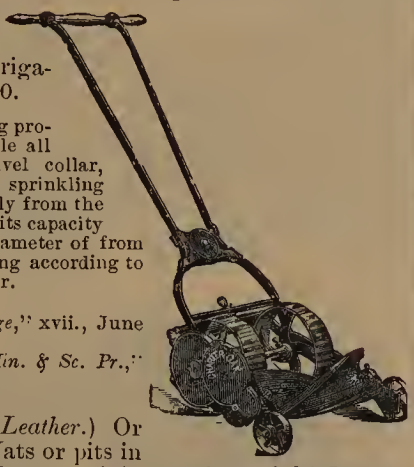
"Ajax," . . . . . * "*Iron Age*," xxi., May 23, p. 7.
"Buckeye," . . . . * "*Iron Age*," xxi., April 25, p. 9.
Hanley . . . . . * "*Scientific American*," xlii. 147.
"Pennsylvania," . . * "*Iron Age*," xxi., March 28, p. 1.
* "*Scientific American*," xl. 211.
"Phila." . . . . . "*Scientific Amer.*," xxxviii. 249.

Lawn Sprinkler. A garden and lawn irrigator. Fig. 1560.

The water being projected at an angle all around the swivel collar, falls like rain, sprinkling the ground evenly from the center outward, its capacity being across a diameter of from 30′ to 45′, varying according to the head of water.

Peck * "*Iron Age*," xvii., June 8, p. 5.
Revolving * "*Min. & Sc. Pr.*," xxxvii. 153.

Fig. 1559.



"*Charter Oak*" *Lawn Mower.*

Lay'ers. (*Leather.*) Or *Layaways.* Vats or pits in which the sides are laid away or stratified with ground oak-bark after coming out of the *stringers.* The sides are laid flesh down, to prevent the hook scratching the grain in taking out. The *layers* contain the strongest infusion of oak-bark.

Fig. 1560.

Lawn Sprinkler.

La'zy Cock. See JET VALVE.

La'zy Paint'er (*Boat.*) A small temporary boat rope, for fine weather.

Leach'ing Vat. A tub or tank in which lixiviation of soluble substances is performed.

See Augustin leaching plant, by Vinton, in "*Eng. & Min. Jour.*," * xxv. 342.

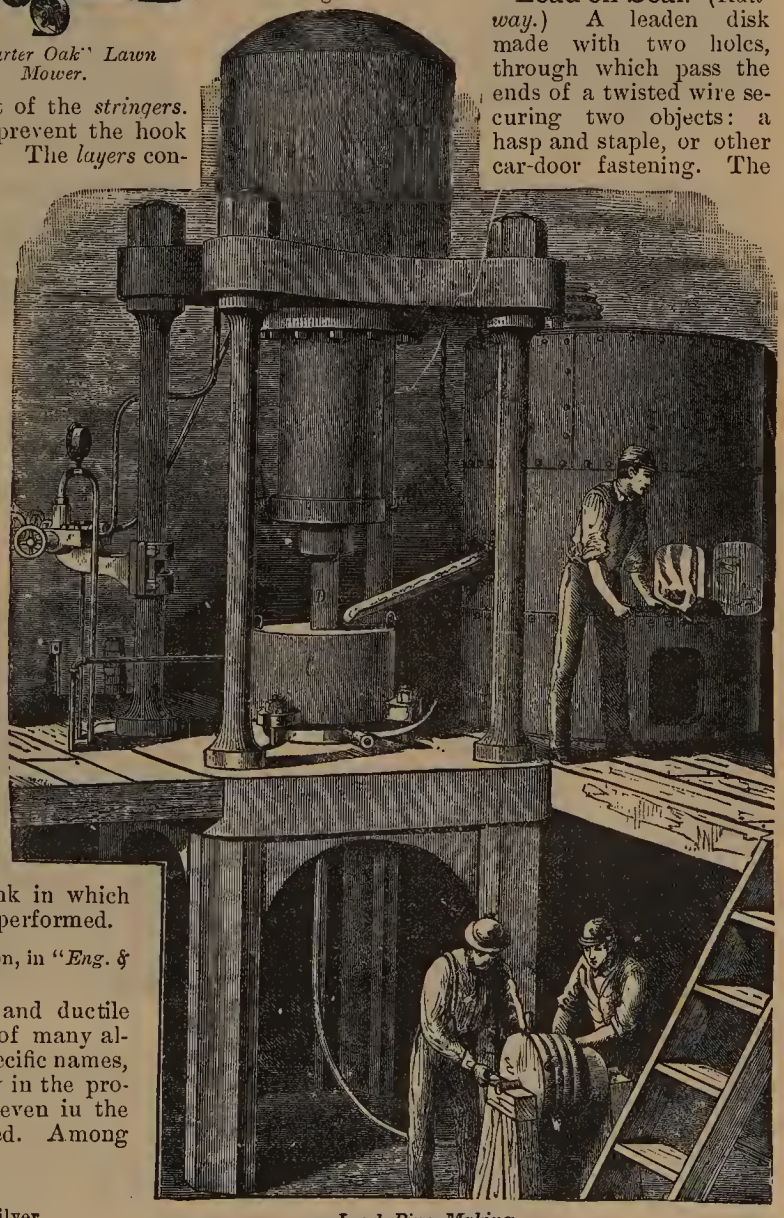
Lead Al-loy'. This cheap and ductile metal enters into the composition of many alloys which are known by various specific names, and which themselves vary greatly in the proportions of their ingredients, and even in the number of elements thus associated. Among these alloys may be named —

Albata
Fusible alloys.
Biddery.
German silver.
Journal-box metal.
Organ-pipe metal.
Pewter.
Pot metal.
Sabot metal.
Sheathing metal.
Shot.
Solder.
Stereotype metal.
Type metal.

TABLE OF LEAD ALLOYS.

	Lead.	Antimony.	Tin.	Arsenic.	Bismuth.
Sheathing lead .	94	6	–	–	–
Journal box metal	24	4	–	–	–
Soft bearing metal	20	4	–	–	–
Organ pipe metal .	5	–	5	–	–
Shot	100	–	–	2	–
Expanding alloy .	18	4	–	–	1
Type metal from to	6 to 14	2 to 2	–	–	–
Stereotype metal .	40	8	2	–	–
Coarse solder . .	6	–	2	–	–
Fine solder . .	2	–	4	–	–
Soft solder . . .	4	–	2	–	–
Bismuth solder .	5	–	3	–	7

Fig. 1561.



Lead Pipe Making.

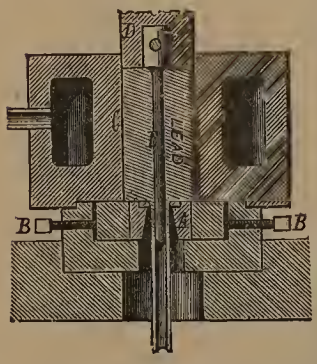
Lead'en Seal. (*Railway.*) A leaden disk made with two holes, through which pass the ends of a twisted wire securing two objects: a hasp and staple, or other car-door fastening. The

lead is then pressed down by a stamp and the fastening cannot be detached without cutting the wire or defacing the seal.

Lead'er. (*Fishing.*) A net so placed as to intercept fish and lead them into a pound, weir, trap-net, etc. See POUND. It is a net fence that guides the fishes which attempt to get round it into the heart. It is usually made in pieces 10 rods in length. See HEART SEINE, *supra*.

Lead Pipe. The lead pipe press is shown in perspective in Fig. 1561, on page 533. Lead pipe is made by forcing the congealed lead through a die, in the axis of which is a mandrel, as shown in Fig. 1562. The hydraulic press is used.

Fig. 1562.



Lead Pipe Die.

The die *A* is a metallic disk which fixes the outside diameter of the pipe, and is adjustable by set screws *B B* to bring it in line. The lead receptacle *C* is heated by steam. *D* is the press plunger and from it depends the core or mandrel *E*, which occupies an exactly axial position in the die and determines the bore of the pipe. The plunger being raised, a charge of metal is run into the chamber; the plunger is then depressed and forces the metal out in the annular space between the core and the die. The pipe is reeled up as made.

Tin-lined pipe is made by a modified process. Before the lead is run into the chamber, a mandrel is inserted, which closes the die aperture and extends up through the receptacle. This mandrel consists of a central stem, around which are grouped dovetailed sections, so that when the central portion is removed the sections are easily taken out, leaving a hollow space in the lead, which is run in while the mandrel is in place. The sides of the mandrel are tapered, or rather crenelated, there being three or four shoulders and a different taper from each. The object of this is that after the mandrel is removed, the tin which is poured into its place may have several purchases against the lead which surrounds it. Before the tin is let in the core is inserted. Afterwards the pressure is applied in the usual manner, the result being that the pipe emerges with a thin lining of tin.

Protecting from corrosion by water: —

Treat for 15 minutes with a 2 to 5 per cent. solution of sulphuret of potassium or sodium at 212° Fah. *Dr. Schwartz*, Breslau, No. 1,519, British Patent Reports, 1863.

A boiling solution of sulphur in caustic answers the same purpose.

Or, "by causing a warm concentrated solution of sulphide of potassium to flow through the pipe for 20 minutes." "*Revue Industrielle.*"

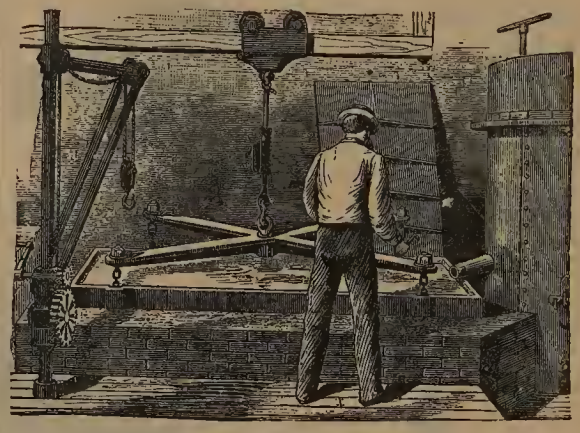
Lead Pro'cess. See the following: —

Altenace	*Painter's* "*Rept. Vienna Exp.*," iv. 106.
Blast-furnace, *Clerc*	* "*Eng. & Min. Jour.*," xxii. 248.
Bleyberg	*Painter's* "*Rept. Vienna Exp.*," iv. 1.
Bohemiau . . .	*Painter's* "*Rept. Vienna Exp.*," iv. 159.
Carinthian . . .	*Painter's* "*Rept. Vienna Exp.*," iv. 169.
Clausthal	*Painter's* "*Rept. Vienna Exp.*," iv. 101.
Clausthal	* "*Engineering*," xxv. 19, 57.
Clausthal furnace .	* "*Engineering*," xxiv., 259, 319, 383, 428.
Crosby, lead bath .	Fig. 2855, p. 1270, "*Mech. Dict.*"
Desilverizing process.	
Rozan, Fr. . . .	*Blake's* "*Rept. Vienna Exp.*," iv. 10.
Desilvering . . .	p. 689, "*Mech. Dict.*"
Fuller, lead bath .	Fig. 2853, p. 1269, "*Mech. Dict.*"
Hasenclaver-Helbig	* "*Report Vienna Exp.*," iv. 147.
Harz, smelting pro.	*Painter's* "*Rept. Vienna Exp.*," iv. 99.
Holloway, ore proc.	"*Iron Age*," xxiv., July 31, p. 15.
Holzappel	*Painter's* "*Rept. Vienna Exp.*," iv. 151.
Lautenthal . . .	*Painter's* "*Rept. Vienna Exp.*," iv. 118.
Lead Bath	* p. 1269, "*Mech. Dict.*"
Nassau	*Painter's* "*Rept. Vienna Exp.*," iv. 154.
Pattinson's pots .	Fig. 3574, p. 1639, "*Mech. Dict.*"
Pibram	*Painter's* "*Rept. Vienna Exp.*," iv. 163.
Pipes, action of water	"*Scientific American*," xxxv. 179.
Pipe press	* "*Manuf. and Builder*," ix. 173.
Rhenish	*Painter's* "*Rept. Vienna Exp.*," iv. 143.
Rose, lead bath . .	Fig. 2854, p. 1269, "*Mech. Dict.*"
Schemnitz . . .	*Painter's* "*Rept. Vienna Exp.*," iv. 179.
Silver-lead furnace	Fig. 5094, p. 2183, "*Mech. Dict.*"
Stolberg, furnace .	*Painter's* "*Rept. Vienna Exp.*," iv. 59, 149.
Styrian	*Painter's* "*Rept. Vienna Exp.*," iv. 172.
Tyrolese	*Painter's* "*Rept. Vienna Exp.*," iv. 165.

Lead Sheet. Sheet lead is made by running a flat ingot of lead repeatedly through a rolling mill until the required thickness of the sheet is reached.

The lead is run into a flat cake weighing about 4 tons, and having a size 7′ 10″ × 5′. After cooling in the mold, which takes some days, it is lifted out by the crane and carried by the overhead tackle to the mill, where, after the edges have been adzed true, it is passed and repassed between the rolls some 150 times, till it becomes 30′ × 7′ 10″, the original longer dimension being maintained, while the narrower dimension of 5′ has become 30′, more or less, according to the original thickness and the degree of tenuity or thinness of the rolled sheet, say a weight of 30 pounds to the square foot. The sheet is then cut up by vertical knives actuated by a screw, in a frame which is adjusted so as to cut across

Fig. 1563.

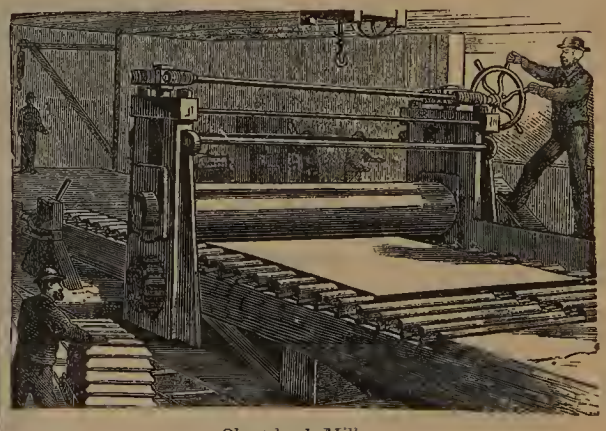


Melting the Lead.

the bed of the mill, and between two of the supporting rollers shown in Fig. 1564. The sections of lead are again rolled into 18′ lengths, varying in weight from 2½ to 10 pounds per square foot, according to the purpose for which they are required.

The mill has a cylinder 30″ diameter and 9′ long, and the bed is a double series of parallel rollers upon which the lead traverses. The vertical adjustment of the ends of the roll are performed simultaneously by hand-wheel at one end, com-

Fig. 1564.



Sheet-lead Mill.

mencing by gearing with the boxing of the roller at the respective ends of the latter.

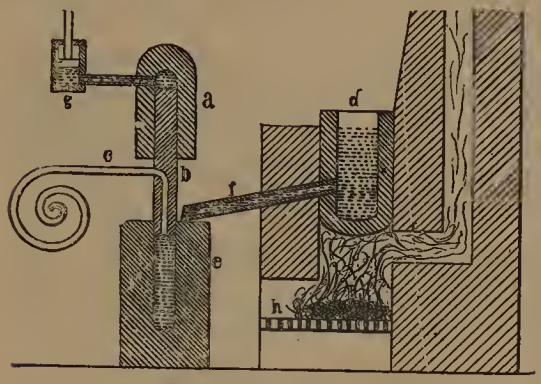
Chinese sheet-lead for lining tea-chests is made by pressing between tiles faced with several thicknesses of unsized paper. These plies act as a non-conductor.

Lead foil with tin surfaces is made by rolling an ingot of lead with layers of tin run upon each side, so as to sandwich the lead between the two. The compound ingot is rolled and re-rolled until the required thinness is attained.

Lead Soap. An insoluble oleate of oxide of lead; spread on cloth to form *diachylon* plaster.

Lead Wire. The apparatus for making lead wire is a copy in miniature of the lead-pipe apparatus.

Fig 1565.



Lead Wire Apparatus.

a. Hydraulic press.
b. Piston perforated with a hole for emission of the lead wire *c*.
f. Pipe for conducting melted lead from furnace *d* to compressor *e*.
g. Force-pump that supplies water to the hydraulic press.
h. Grate bars.

The lead is heated in a pan, conducted to the cylinder of the hydraulic press, forced thence in a wire having the size of the aperture through the plunger, and coiled on a shaft.

Leaf Sight. A form of sight having a hinged plate, known as a *leaf*, and erected for use, but lying flatly on the barrel for safety at other times.

Fig. 1566.

Sporting Leaf Sight.

The leaf is graduated for distance, say for from 100 to 1000 yards, and the slider with the sight notch is raised so that the upper surface coincides with the required graduation. See also HAUSSE, Figs. 1329–1331, p. 447, *supra*.

Leak'age Valve. A small valve used between the triple valve and the brake-cylinder in the Westinghouse car-brake arrangement, to prevent the leakage from the pipes from operating the triple-valve, and thus applying the brakes. See TRIPLE VALVE.

Leak Stop'per. An apparatus for the forcible application of a tampon against the side of a leaky shaft.*

* "*Engineer*," xlv. 373. A segment is forced against the breach by means of a hydraulic jack, then keyed up and wedged.

Leath'er. Tanned or tawed skin.

The principle of tanning: "Take the skin of an animal, remove from it the hair, fat, loose flesh, and other impurities, and immerse it in a dilute solution of tannic acid; the cellular and elastic tissues will gradually combine with that substance, as it penetrates toward the interior, and will form a compound perfectly insoluble, and which will completely resist putrefaction; this compound is leather." — *Lieut. Lyle.*

The treatment of hides and skins to make the various kinds of leather, including the work of the tan-yard and currying shop, is succinctly told in *Lieut. Lyle's* appendix K to "*Ordnance Report*," 1878, pp. 61–89, under the following heads: —

Sole leather.
Harness leather.
Bridle leather.
Collar leather.
Buff leather
Grain leather.
Wax leather.
Polish leather.
Oil-pebble leather
Trunk leather.
Splits.
Mixed leather.
Skirting leather.
Latigo.
Lace leather.
Bellows leather.
Belting.
Calfskins.

Leath'er, Tan'ning, etc. See under the following heads: —

Abating.
Alligator leather.
Astringents.
Beam.
Blacking.
Bloom.
Bruising.
Boarding.
Buffing.
Chamoied.
Chrome leather.
Clamp.
Clearing stone.
Closing machine.
Dampening.
Daubing.
Dubbing.
Enameled leather.
Flattening.
Flaying knife.
Flesh side.
Fly.
Glassing.
Glassing jack.
Glove cutter.
Glove sewing machine
Graining.
Graining board.
Grain side.
Handlers.
Handling.
Impression-stitch machine.
Jack.
Junk vat.
Layers.
Leather.
Leather dressing.
Leather finishing machine.
Leather furniture.
Leather glazing machine.
Leather grease.
Leather punch.
Leather raising and creasing machine.
Leather rolling machine.
Leather scourer.
Leather splitting machine.
Leather stretching machine.
Leather waterproofing.
Leather whitening machine.
Liming.
Mill.
Pebbling.
Pebbling machine.
Polar oil.
Polishing jack.
Rolling mill.
Rosin oil.
Rub stone.
Scouring.
Scouring table.
Screw soling machine.
Screw press.
Screw wiring machine.
Set.
Shaving.
Shoe embossing machine.
Shoe sewing machine.
Sizing.
Skin-beating machine.
Skiver.
Skiving.
Skiving machine.
Slicker.
Slicking.
Soft boarding.
Sole.
Sole molding machine.
Sole riveting machine.
Sole rolling machine.
Sole screwing machine.
Splitting.
Staining.
Stock stone.
Stoning.
Stoning jack.
Stringers.
Stripper.
Stuffing.
Tanner's knife.
Tanning.
Tawed-leather dresser.
Unhairing machine.
Vat.
Wax-thread sewing machine.
Welt machine.
Whip making.
Whitening.

Elaborate tests of leather by *Theron Skeel*, pp. 13–34, Report on Leather, Group XII., in vol. v., "*Centennial Reports*."

Cf. Artificial leather	"*Scientific American Sup.*,"	849.
Birch-oil for Rus. leath.	"*Scientific American Sup.*,"	845.
Dressing machine.		
Rosensteel	* "*Scientific American*,"	xxxiv. 134.
Enameling machine	* "*Scientific American*,"	xxxiv. 259.
Human skin leather	"*Scientific American*,"	xxxvi. 7.
Manufactory.	* "*Scientific American*,"	xli. 407.
Morocco	"*Scientific American*,"	xl. 386.
Preparing kid skins	"*Man. & Builder*,"	viii. 191.
Scourer, *Lockwood*	* "*Scientific American*,"	xxv. 210.
Stamping mach., *Urner.*	* "*Scientific American*,"	xxxvi. 355.

See LEATHER, IMITATION, and lists, pp. 1275–1276, "*Mech. Dict.*"

Leath'er, Ar'ti-fi'cial. A material made to resemble leather; it sometimes consists of leather waste and scraps agglutinated; or of paper or cloth treated with paints, resins, etc.

See LEATHER, IMITATION, and references *passim*.

Leath'er Board. Leather scraps and manilla of old rope, ground into a pulp, made up in the manner in straw board, and calendered. An article in very great use, not alone in the soles of cheap shoes, but for making drums, chair-seats, toys, etc.

Leath'er Ce-ment'.

Molesworth.	Gutta percha	16
	India-rubber	4
	Pitch	2
	Shellac	1
	Linseed oil	2

melted and mixed.

Water-proof Cement: Chase.

Ale	1 pint.
Russia isinglass	2 ozs.

Dissolve, and add common glue, 4 ozs.; then add slowly, linseed oil, 1½ ozs., stirring well. Dilute in ale, put on hot with a brush, and weight the objects united.

To fasten Leather to Iron: Steep the leather in infusion of gall-nuts. Spread hot glue on the metal. Apply leather under forcible pressure, and allow it to dry without relieving pressure.

For joining pieces of leather: —

Bisulphide of carbon	10
Turpentine	1

Add gutta percha to thicken the composition. Free the leather from grease, and press the joint till the cement is dry.

Water-proof Cement. Moore: Gutta percha dissolved in bisulphide of carbon. Warm the parts, and maintain the pressure till dry.

Leath'er Cloth. An imitation leather. See LEATHER, IMITATION.

Leath'er Dress'ing.

Castor oil.

An adhesive: printer's ink.

For belts:	Beef kidney tallow	1
	Castor oil	2

An adhesive, powdered chalk.

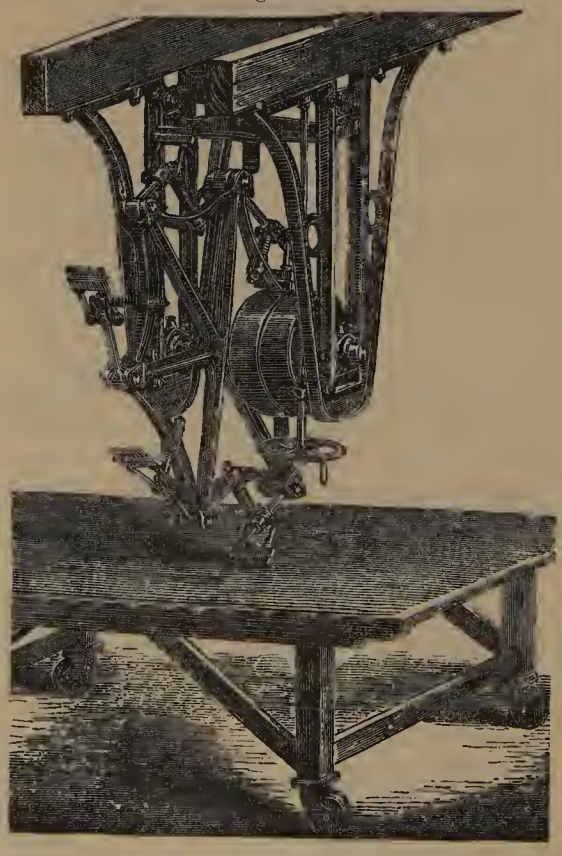
For belts:	Fish oil	4
	Lard or tallow	1
	Colophonium	1
	Wood tar	1
Or:	Tallow	2
	Bayberry tallow	1
	Beeswax	1

Heated to boiling, and laid on with a brush, and the beeswax driven into the belt by holding a hot iron plate against it.

See also HARNESS GREASE, p. 439, *supra*.

Leath'er-ette'. An imitation of leather. A compound of fiber and some agglutinating materials, finished by passing between leather-covered rollers to give the surface imitation. See LEATHER, IMITATION.

Fig. 1567.



French Leather Finishing Machine.

Leath'er Fin'ish-ing Ma-chine'. A machine for giving the texture and surface finish to leather by means of a vibrating slicker or roller, according to the requirement.

Graining, glossing, glassing, slicking, polishing, pebbling, dicing, are all terms within the definition of *finishing*.

The machine shown in Fig. 1567 has tools revolved by machinery, the pressure being due to a spring at the back of each tool-stock. The leather is upon a table on casters, so that a fresh surface of leather can be brought within the range of the tool by moving the table. The tool-head is a hexagonal frame, like a six-spoked wheel, and as it revolves each of the six slickers (for instance) in turn presses upon the surface of the leather. A hand-wheel adjusts the pressure by raising or lowering the boxing of the wheel.

Leath'er Gla'zing Ma-chine'. One for giving a surface gloss to leather. The glassing tool is reciprocated over the skin, compacting the surface, giving it a polish, and raising the grain.

The reciprocating tool, in imitation of the hand, is shown in LEATHER FINISHING MACHINE, "*Mech. Dict.*," *et supra*. The *Baker* machine, shown at Fig. 1568, is a more compact form,

Fig. 1568.

Leather Glazing Machine.

and has all the strain within itself. It is shown without the table on each side on which the skin lies. The machine occupies a narrow space between two tables, and the skin passing across the interval rests on a bed, and its upper surface is subjected to the pressure of the *glass* which reciprocates above it, being effective on one stroke, and the pressure relieved on the return.

Leath'er Grease. See LEATHER DRESSING; HARNESS GREASE.

Leath'er, Im'i-ta'tion. See the following recipes: —

Paper treated with dilute sulphuric acid, so as to become toughened. Parchment paper.

Leather parings and caoutchouc worked by a machine into a homogeneous fibrous mass, gelatinized with ammonia water, and rolled into sheets, or pressed in molds. — *Sören Sörenson*, "*Deutsche Industrie Zeitung.*"

Leather fibers from leather offal, treated like paper stock; made into a pulp, mixed with flax fiber, and then treated as in paper manufacture. — *Rice, Kendall & Co.*

Sheets of carded wadding placed on polished heated metallic plates, and then saturated with a decoction of pearl-moss, fucus, or laminaria, and dried. The metal gives a polished surface to the material, which is then rolled between heated rollers, to give it compactness and the required thinness. It is then coated with boiled linseed oil and dried by artificial heat. When dry, coat with vegetable wax, and soften by passing between fluted rollers. It is then surfaced by rollers, which give it the appearance of morocco, pig-skin, or what not; or is varnished, bronzed, enameled.

Thicken decoction of fucus with cotton waste, and treat as paper pulp, or papier-maché.

Cocoa-nut fiber or waste of rope, hemp, or flax, treated with fucus, or any mucilage, and rolled into floor cloth.

Cork powder and caoutchouc. See CAMPTULICON, p. 435, "*Mech. Dict.*"

Cork powder incorporated with paper pulp. See CORK BOARD, p. 220, *supra*.

Caoutchouc or its analogue compounded with camphor and sulphur, and vulcanized. — *Gerner.* See HEVEENOID, p. 457, *supra*.

Heavy cottou cloth treated with dilute sulphuric acid, and then saturated with resinous compounds or paint.

Asbestos treated with gums, pigments, etc.

Leather ground into fiber, mixed with vegetable fiber, saturated with gummy solutious and paint. See BOULINIKON, p. 124, *supra.*

A number of compositions are given under LEATHER, ARTIFICIAL, pp. 1276, 1277, and LEATHER PAPER, p. 1278, "*Mech. Dict.*"; they consist of various materials compounded or associated: fiber, gums, resins, oils, gelatine, leather scraps, clay, gypsum, oxides, pigments

Some compositions resemble leather in its more solid aspects as molded, but have not the pliability which is an ordinary characteristic of leather.

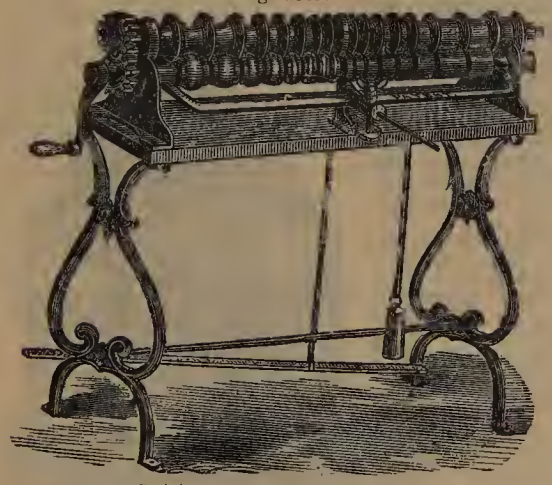
Such are *Bois-durci*, p. 320, "*Mech. Dict.*"
Bonesilate, p. 130, *supra.*

See also other titles under COMPOSITIONS, p. 212, *supra.*
"*Manuf. & Builder,*" iv. 143; vi. 73, 192, 339; vii. 275.
Millwood, "*Technologiste,*" xli. 243.
"*Scientific American Supplement,*" 135, 227, 692.

See also LEATHER BOARD; LEATHERETTE; LEATHER CLOTH; LEATHEROID; LEATHER WASTE.

Leath'er-oid. An artificial substance resembling leather in appearance, and serving as a substitute for it for some purposes. It is made in two varieties: one soft and flexible, the other like vulcanized rubber, and susceptible of a polish. See LEATHER, IMITATION.

Fig. 1569.



Raising and Creasing Machine.

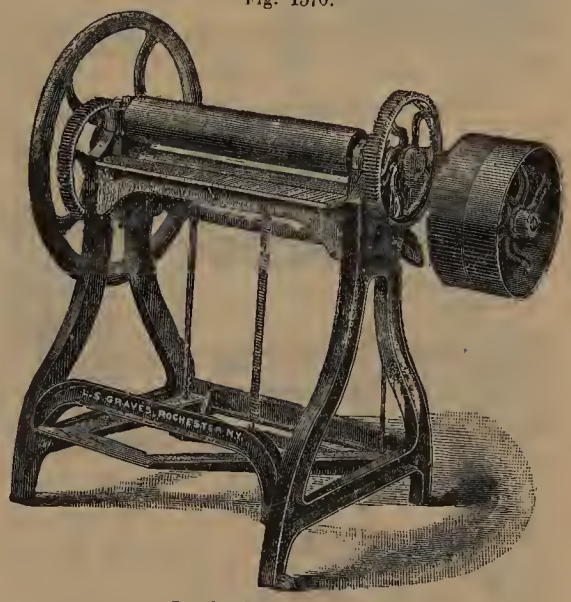
Leath'er Rais'ing and Creas'ing Ma-chine'. A machine for ornamenting straps, leather reins, saddle skirts, etc., by raising a ridge, giving a molded or wavy edge, or what not, according to the pattern of the rollers, between which the dampened leather is passed.

Fig. 1569 shows a machine with a numerous assortment of passes of varying widths and patterns, adapted to raising, creasing, stretching, polishing, and waving.

Leath'er Rol'ling Ma-chine'. A machine to compress and harden leather, as a substitute for the hammer and lap-stone.

The one shown in Fig. 1570 is a small-sized machine,

Fig. 1570.



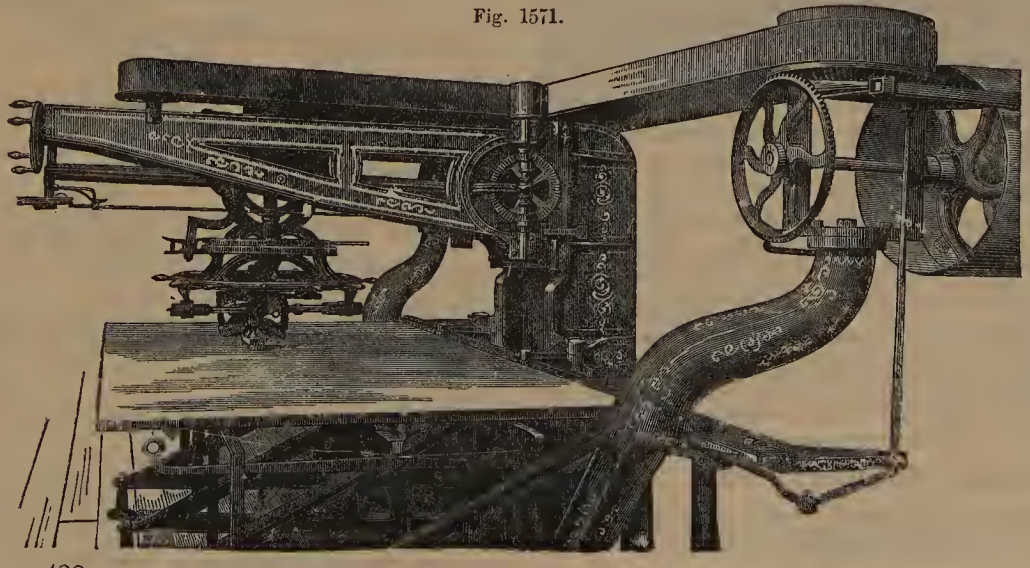
Leather Rolling Machine.

adapted to be run by hand or by power. The pressure, is given by the weight of the operator on the treadle, transferred by levers to the upper roll.

Leath'er Scour'ing Ma-chine'. A machine for working tanned and curried skins, bringing the pressure of a reciprocating tool upon the hide in successive strips as the skin is moved beneath it from time to time in a direction transverse to the motion of the tool.

The texture and elasticity, as well as the surface appearance of the leather depend upon this intermittent pressure, which glazes the surface and raises the grain, while also affecting the body of the leather. The machine simulates the

Fig. 1571.



Leather Scourer and Hide Worker.

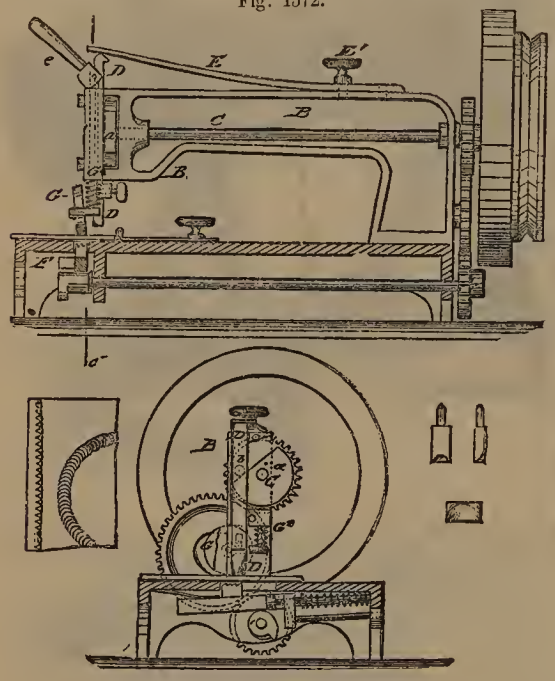
hand processes in reciprocating a comparatively narrow tool in direct lines over the surface, a strip at a time. Under LEATHER FINISHING, and LEATHER GLAZING, machines similarly actuated are shown. See also LEATHER MACHINERY, pp. 1277–1282, "*Mech. Dict.*"

Lockwood's machine, Fig. 1571, is capable of any required pressure, is universal in its movements, and so far automatic that the strength of the finger will guide its movements. It will scour, set out, or gloss; will take a slow or quick, a long or short stroke.

Leath'er Stamp'ing Ma-chine'. A machine for producing ornamental designs on leather for saddle flaps, carriage aprons, chair and sofa seats and backs, books, portfolios, etc.

Urner's machine is shown in Fig. 1572. The upper revolving shaft, *C*, works the stamp rod *D*, which moves in a guide in the arm *B*, and is acted upon by a band spring, *E*.

Fig. 1572.



Leather Stamping Machine.

The spring may be adjusted by the clamp screw *E'*. The shaft *C* raises the stamp rod by means of a cam, *a*, which engages with a friction roller, *b*, on the rod; on being released from the cam, the rod is brought down forcibly by the spring. Either of the variously-shaped stamping bits may be clamped into the lower portion of the stamp rod *D*. The leather is fed by a vibrating feed mechanism, *F*, and retained by a presser wheel, *G*, which is attached to an arm on a presser rod, G^2, which is pushed down by a coiled spring, and raised or lowered by the lever *e*. A piece of leather, as marked by the machine, is shown at the side. The mechanism is operated by the belt wheel and gearing on the right.

Leath'er Waste. Utilized in the making of imitation leather by various processes. That of Sörenson, of Copenhagen, is as follows: —

The leather waste is first washed, after which it is reduced, by tearing, stamping, cutting, rasping, or rubbing, to a uniform and fibrous condition. When reduced to this finely divided condition, the leather is treated with ammonia water, by which it is converted into a gelatinized mass, which, when pressed into molds, or rolled out between rollers, and dried, makes a very hard and stiff product, having considerable cohesiveness, but without elasticity and soluble in water.

To make an elastic and water-proof fabric, the material is treated with caoutchouc dissolved in benzine, the mass kneaded, and then rolled or pressed into shape.

"*Bay. Industrie u. Gewerbe Blatt*" . viii. 140.

Leath'er Wa'ter-proof'ing.

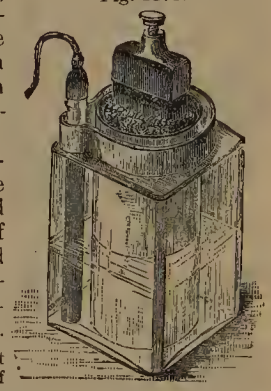
MacKenzie. Mixture of drying oil and oxides of lead, copper, or iron: or gummy resins in place of oxides.

Or: Caoutchouc shredded into and dissolved in warm copal varnish.

Or: Glue, 12 ozs., dissolved in water. Add Rosin, 3 ozs. Melt, and add Turpentine or benzine, 4 ozs.

Leath'er Whi'ten-ing Ma-chine'. (*Leather.*) A machine for doing the work otherwise performed by the knife at the beam; cleaning the hide by passing the knife with a fine edge lightly over the flesh side to bring it to a clean and fit condition for waxing.

Fig. 1573.

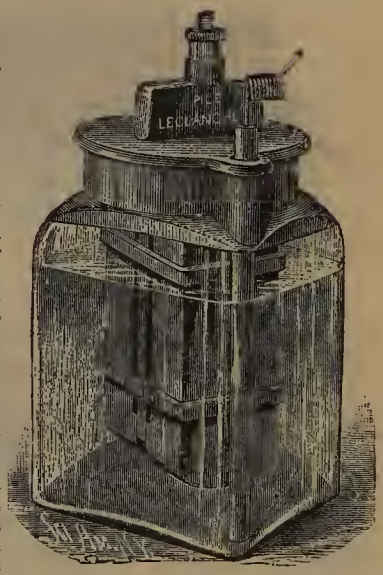


Leclanché Battery. (*Porous Cup.*)

Le'clanché Bat'te-ry. (*Electricity.*) One having its amalgamated zinc in a dilute solution of chloride of ammonium, and the carbon plate in a mixture of peroxide of manganese and coke. Fig. 1573.

In the Leclanché improvement the positive pole is composed of a plate of carbon inserted between, and in connection with two compressed prisms of peroxide of manganese and carbon (with a small cylinder of hi-sulphate of sodium in the center of the electrode), the three being held firmly together by rubber bands. The object of the acid salt is to prevent the formation of the oxychlorate of zinc.

Fig. 1574.



Leclanché Battery. (*Prism.*)

The negative pole is composed of a pencil of amalgamated zinc.

The two poles are set in a solution of sal-ammoniac and water contained in a glass jar, with a cover through which the carbon head and the zinc project.

As the zinc is indefinitely preserved without alteration in the sal ammoniac, and as the peroxide of manganese is insoluble in this liquid, no internal chemical action takes place when not in use.

Niaudet, American trans., N. Y., 1880 * 180, 181.
Prescott's "*Electricity*" . . . . . * 75.
Ganot . . . . . * 691.
"*English Mechanic*" . . . . . * xxiii. 157.
* "*Scientific American*,". . . . * xxxv. 115; xxxix. 195.
"*Scientific American*" . . . . . * xlii. 198.
"*Scientific American Supplement*" * 2728.
"*Technologiste*" . . . . . xxxvii. 140.
Improved, "*Telegraphic Journal*" . * vi. 223.
"*Telegraphic Journal*" . . . . iv. 213.
"*Scientific American Supplement*" 3033, 3238.
"*Iron Age*" . . . . . xviii., Sept. 21, p. 19.
Electro bronzing, "*Teleg. Jour.*" . vii. 234.
Gaiffe's impt., "*Sc. Amer. Sup.*" . * 129: 3187.
"*Telegraphic Journal*" . . . . vi. 185.

In *Clark & Muirhead's* improvement the carbon electrode as well as the carbon fragments are platinized to reduce polarization. —*Niaudet*, American translation, 193.

"*English Mechanic*" . . . . . * xxiii. 191.
Howell's modification, "*Sc. American Sup.*" . . 3791.

Leech, Ar'ti-fi'cial. A form of uterine leech and aspirator by Dr. Reese, for depleting the engorged neck of the uterus, is a graduated glass cylinder $7\frac{1}{2}''$ long and $\frac{1}{2}''$ diameter, with a piston, through which is conducted a metallic rod with a

spear point. The point is retracted by a spring after puncturing, and the blood aspirated by withdrawing the piston. — *Tiemann.*

Leg, Ar'ti-fi'cial. See Figs. 2894–2898, pp. 1284, 1285, "*Mech. Dict.*"

Dr. J. H. Thompson's report on Group XXIV., "*Centennial Exhibition Reports*," vol. vii., gives account of the following: —

Verduin (Paris, 1696) . . * p. 31.
Martin, French . . . * p. 33.
Charrière, French . . . * p. 33.
Bichard, French . . . * p. 33.
Mathieu, French . . . * p. 33.
Palmer, U. S. . . . . * p. 37.
Palmer, U. S. (1873) . . * p. 41.
And mention of numerous others exhibited.

Fig. 1575.

Leg Support.

Leg Boot. (*Manége.*) A horse-boot which extends from the hoof to the knee; it is made of soft leather, closely fitted to the leg; its principal use is to protect the horse's leg from injury by ice or mud.

Leg Sup-port'. An apparatus to modify the effects of, or cure bow-legs, knock-knees, weak ankles, shortened limbs, and other deformities and deficiencies.

Fig. 1575 shows right and left apparatus for several parts.

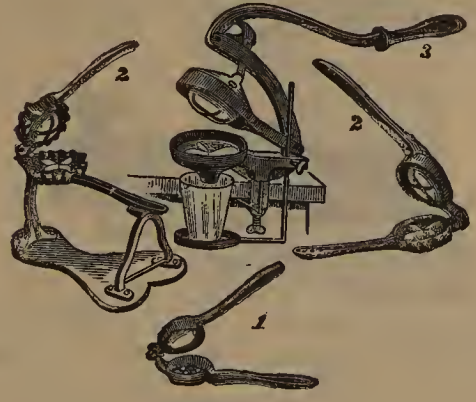
See Fig. 6084, p. 2459, "*Mech. Dict.*"

See also references under CURVATURE APPARATUS, p. 236, *supra*.

Lem'on Squeez'er. One for pressing the juice from lemons.

Fig. 1576 shows several forms of the *Sammis* lemon squeezer.

Fig. 1576.



Lemon Squeezers.

1. For half lemons.
2. For cutting and squeezing whole or half lemons.
3. Large size, lever power for hotels and bars.

Length. (*Mining.*) A certain portion of the vein when taken on a horizontal line.

Lens For'ceps. (*Surgical.*) An instrument for withdrawing an opaque lens in the operation for cataract.

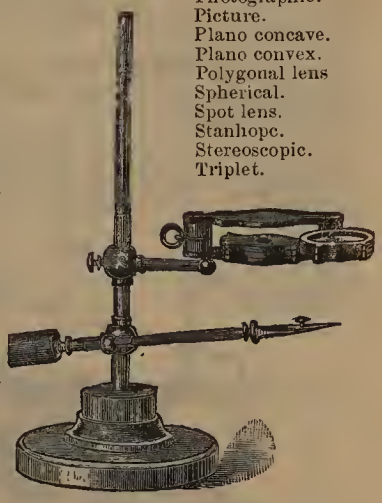
Critchet's and *Graefe's* lens scoops and spoons and others of silver, hard rubber, and shell, as well as lens forceps, are shown on pp. 30, 31, Part II., *Tiemann's* "*Armamentarium Chirurgicum.*"

Lens Hold'er. A support for a lens or combination of lenses, while an object is adjusted to the focus on an adjustable sliding forceps or a stage beneath. Fig. 1577.

For history, forms, and manufactnre of lenses, see p. 1286, *et seq.*, "*Mech. Dict.*"

Achromatic.
Aplanatic.
Bull's eye.
Coddington.
Coucavo-convcx.
Condensing lens.
Convex.
Convexo-concave.
Crossed.
Cosmorama lens.
Cylindrieal.
Demonstration lens.
Diacaustic.
Diamond.
Double-concave.
Double-convex.
Doublet.
Eye glass.
Field lens.
Fluid lens.
Fresnel's.
Immersion objective.
Lunette.
Meniscus.
Multiplying.
Object glass.
Objective.
Orthoscopic.
Periscopic.
Photographic.
Picture.
Plano concave.
Plano convex.
Polygonal lens
Spherical.
Spot lens.
Stanhope.
Stereoscopic.
Triplet.

Fig. 1577.



Lens Holder.

Lenses and lens-making.
Chevalier . . . . . * "*Scientific American Sup.*," 2203.
Grinder . . . . . * "*Scientific American*," xliii. 51.
Manufacture of . . . * "*Scientific American.*" xli. 159.
Photograph., *Voigtlander* * "*Scientific American Sup.*," 1849.
Variable focus, *Dr. Cusco* * "*Scientific American*," xliii. 131.

Len-tic'u-lar Knife. (*Surgical.*) A scraper used in osteotomy. A sharp-edged disk is attached to the end of a staff, in a plane at right angles to the handle.

Let'ter Bal'ance. Scales graduated for letter postage. Usually in two sizes: one varying from ½ ounce to 8 ounces; the other from ½ ounce to 4 pounds. The latter to include printed matter.

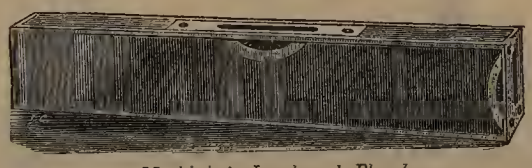
One form of letter balance has two beams, one graduated to ounces and fractions, and the other to metric weights.

Lev'ee. See JETTY.

Lev'el. 1. An instrument for determining horizontality. The subject is treated on pp. 1293 *et seq.*, "*Mech. Dict.*"

The machinist's level is shown in Fig. 1578. It has brass side-views, brass top and end plates, and corners, protected by ¼" square rods extending the entire length of the rosewood staff

Fig. 1578.



Machinist's Level and Plumb.

2. A level, used by Prof. Aita in the survey of Padua, for drainage and water service, was devised to overcome the difficulty of leveling in tortuous streets.

It consists of two glass tubes, doubly clamped to graduated staffs, and connected by a caoutchouc tube of any desired length. The two clamps are movable, the glass tubes being partly, and the connecting tubes wholly filled with water. The observers at the respective ends bring the clamps to the levels of the water in the respective tubes, and each enters the scale-reading in his note book. When the books are compared, the difference of readings give the difference of altitudes.

3. Attached to a gun to indicate its exact position.

Latta, Patent No. 181,530 *Haskell*, Patent No. 175,702.
Several forms . . . . * "*Scientific American Sup.*," 2110.
Aita, Italy . . * "*Engineer*," xliv. 39.

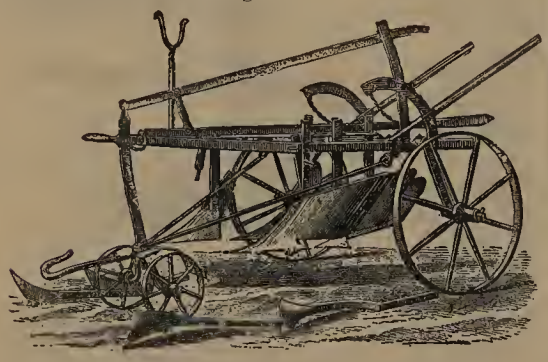
Apparatus, *Ecroyd* . . * "*Scientific American Sup.*," 1379.
Land, *Lowe* . . . . . * "*Scientific American Sup.*," 192.
Rod, *Whitehouse* . . . * "*Scientific American*," xxxv. 278.
Target, *Cleseler* . . . * "*Railroad Gazette*," viii. 131.
Allen . . . . . * "*Railroad Gazette*," 191.

See *Simms'* "LEVELING."

Lev'el-ing Plow. One for plowing down ridges thrown up in some forms of row culture; beets, for instance.

Fig. 1579 is a French form by *Delahaie-Tailleur & Bajac*, of Liancourt, which is adapted for a still greater breadth. The shares are thrown into or out of the soil by a single lever, and their working depth is regulated by the two rear levers,

Fig. 1579.



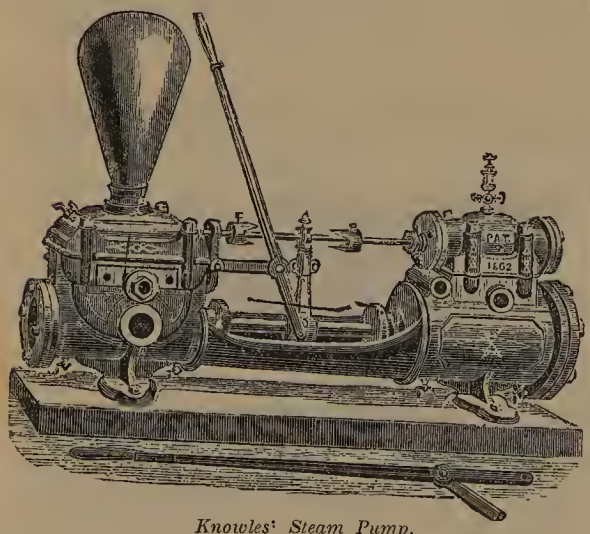
French Leveling Plow.

which actuate the bent axles of the hind wheels, so that the plows may penetrate the depth desired, or, as in the figure, be lifted clear of the soil in moving from place to place.

Lev'el-ing Screw. (*Milling.*) One in the hurst of a mill, acting against an iron plate in the back (beneath) of a bed-stone in order to adjust it vertically and bring it to an exact level. The runner is then *trammed* in accordance therewith.

Lev'er. (*Steam Engine.*) A hand-rod for moving the valves in the starting or reversing of an engine.

Fig. 1580.



Knowles' Steam Pump.

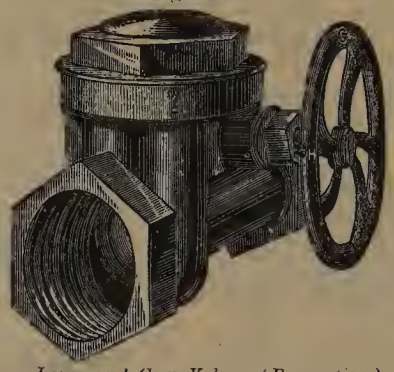
Fig. 1580 shows the hand-power lever of a steam-pump, and the lever detached.

(*Fire-arm.*) The piece by which the gun is opened or closed in some forms of breech-loaders. It may be *top*, *side*, or *under* lever. Examples are found in the Douglas, Henry, Maynard, and other rifles.

Lev'er and Cam Valve. A form of valve for gas or water mains.

The gate *A* moves on guides *B B*, which are arranged to

Fig. 1581.

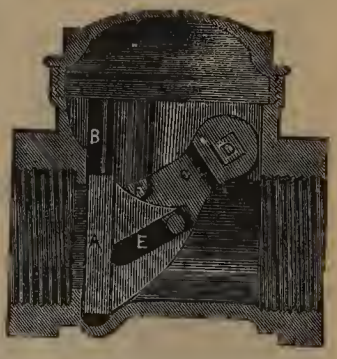


Lever and Cam Valve. (*Perspective.*)

prevent friction by keeping the gate, when moving, from contact with the seat and wall of the valve chamber. The gate is opened and closed by means of the lever arm *C* attached to the rock shaft *D* and working in the slot *E*. When the gate is nearly down, the cam *F* forces it forward and down to its seat. One quarter turn of the wheel, which may be replaced by a straight arm or lever, opens or closes the valve.

Lever valve, *Young*, Br., * "*Engineer*," l. 494. * "*Sc. Am.*," xxxix. 19.

Fig. 1582.



Lever and Cam Valve. (*Section.*)

Lev'er Compres'sor. (*Optics.*) A means for applying pressure to an object whilst under examination with the microscope.

A screw is attached to a lever carrying a piece of glass and working on another plate in which a second glass is fixed and upon which the object is placed.

Fig. 1583.

Lever Compressor.

Lev'er Drill. A machine tool in which the tool spindle works with a spline in the socket of the wheel which rotates it, and is projected axially by a lever to bring it toward or away from its work. The spindle is counterbalanced and has a vertical movement of $7\frac{1}{2}''$. Fig. 1584.

The table is revolvable, and is also vertically adjustable by rack and pinion.

Lev'er Fau'cet. One opened by a lever and closed by a spring. See *a*, Fig. 232, p. 81, *supra*.

Lev'er Hand'-car. (*Railway.*) One worked by levers connected to cranks.

Lev'er Han'dle-cock. A faucet, the handle of which projects as a lever on one side only. See Fig. 234, p. 81, *supra*.

Lev'er Hook. (*Fishing.*) One so arranged that when the fish pulls at the bait, another hook strikes it and makes it fast. See list on p. 341, *supra*.

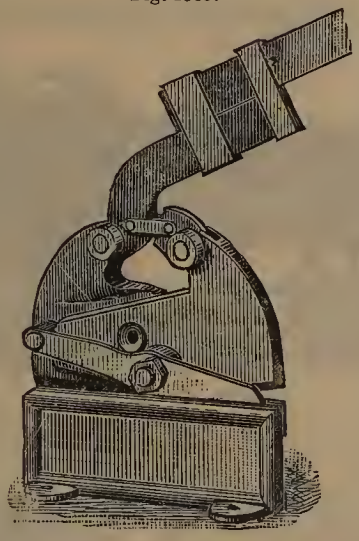
Lev'er Pla'ter. A form of calendering machine in which the force of compression is applied through the instrumentality of levers. See PLATER.

Fig. 1584.

Lever Drill.

Lev'er Press. A press for cutting or stamping tin ware, for instance, in which the punch or stamp is worked by a foot-lever; as distinct from a *pendulum*, *cam*, *screw*, or *fly press*.

Fig. 1585.



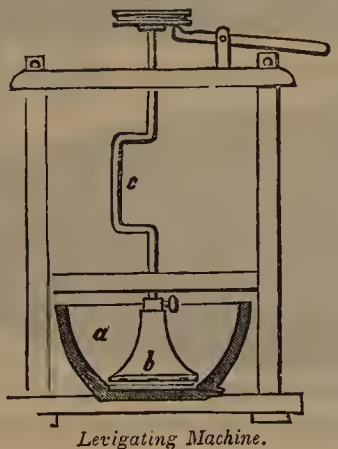
Lever Shears.

Lev'er Shears. A metal shears in which the power is applied by means of a lever; as in Fig. 1585, which is a French sheet metal shears having spur teeth on the contacting cams by which the motion of the lever is applied to the jaw.

Lev'er Valve. One moved by a lever.

See LEVER; LEVER AND CAM VALVE; LEVER COCK.

Fig. 1586.



Levigating Machine.

Lev'i-ga-ting Ma-chine'. The porcelain levigating machine consists of a Thuringian porcelain mortar, *a*, with a flat-bottomed grooved pestle, *b*. This is attached to an iron crank, *c*, which is mounted in a strong wooden frame. There is a spout at the bottom of the mortar for running off the mixture when sufficiently ground.

Ley'den Bat'te-ry. (*Electricity.*) A combination of Leyden jars presenting single positive and negative poles.

L. G. R. Large Grain Rifle powder.

Lid In'stru-ments. (*Surgical.*) See EYE INSTRUMENTS; also Entropium forceps, Fig. 1877, p. 805, "*Mech. Dict.*"

Lieb'er-kuhn. A silvered cup, which slides or screws upon the front of the object-glass; light thrown upward by the mirror will be reflected by it down upon the object; by slightly varying the inclination of the mirror, every necessary alteration in the direction of the illumination can be obtained.

Fig. 1587.

Lieberkuhn.

Life. The endurance of a machine, or a part.

Compiled from the returns of 26 Illinois R. R. companies: —

	Years.		Years.
Locomotives	15½	Pine ties	4⅔
Passenger cars	15⅔	Cedar	5¼
Stock cars	10	Truss bridges	9½
Freight cars	11⅓	Trestle bridges	8
Iron rails	7	Pile bridges	9
Steel rails	14	Joints and fastenings	7
Oak ties	7	Fencing	8½

"Locomotives 201, 202, 203, and 204 were placed on the Erie road in the months of June and July, 1854, and have run respectively 635,169, 532,548, 658,548, and 639,186 miles. The engines were equipped with new boilers in 1871, and are still considered good for 8 years more of good service. The locomotives are from the Rogers Works, Paterson." — *Hornellsville (N. Y.) Times.*

For endurance of car wheels, see p. 176, *supra*.

Life and Cur'rent Slide. (*Microscope.*) A slide in which are two oval cells with shallow connecting channel. By pressure on the cover the contents of a cell are caused to traverse the strait and the thin film is observed *in transitu*.

See CURRENT SLIDE, Fig. 748, p. 236, *supra*.

Life Boat. Fig. 1588 represents a number of life boats in section and one in plan. They are derived from a lecture by Mr. Charles H. Beloe, read before the Liverpool Polytechnic Society.

Beginning at the left, above: —

a is the *Greathead* boat. *A A* are air-tight compartments, and *B* a water-tight deck discharging by tubes into the sea.

b is the Yarmouth sailing life boat, with air cases *A A*, and exterior cork fenders outside the gunwale. They are launched empty and the water then admitted to the well to the level of the water outside.

c, *h*, *i*, are views of the Royal National Life Boat. It is self-righting, and is the result of the experience in building the present fleet of life boats, numbering 235. It has side and end air chambers *C*, *D*, ballast *E*, relieving tubes *B* for the deck load of water.

e is *Lamb & White's* life boat. It is built of two thicknesses of plank with prepared waterproof material of an adhesive nature interposed.

f is *Woolfe's* boat.

g, *j*, are boats on the tubular principle.

k is *Hamilton & Co.'s* metallic life boat, which rids itself of deck water by discharge from the end of the boat which may be highest into a space between two bulk-heads, and then lowering it to outside level by means of a plug.

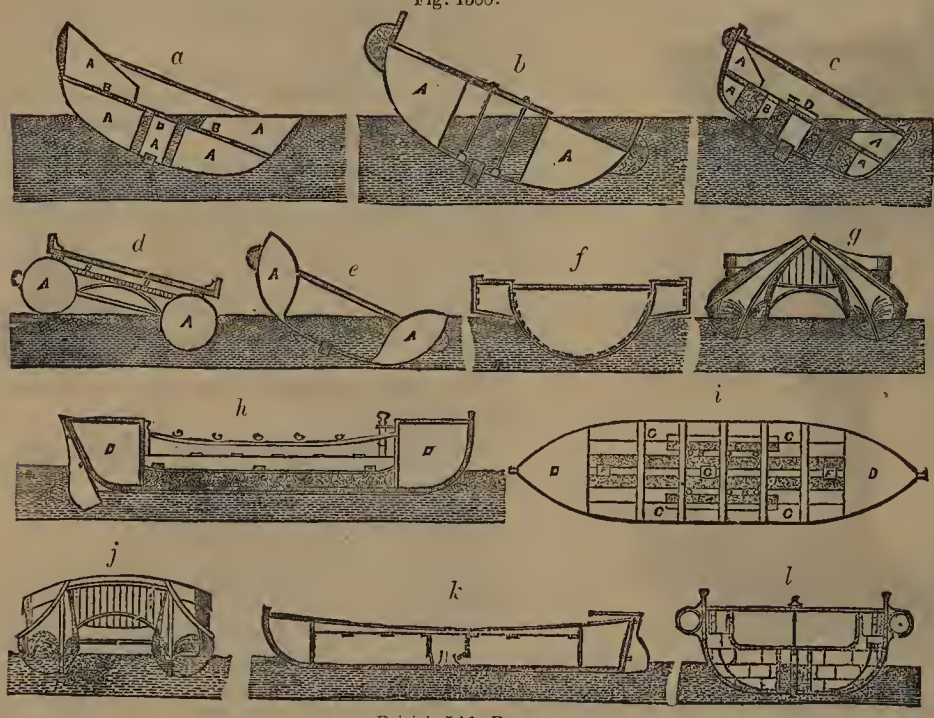
l is *Combe's* cork and cane life boat. It consists of two baskets, one placed within the other, secured to a deep wooden keel, and the intervening space filled with cork.

Fig. 1589 is the Royal Institution self-righting life boat, mounted on its carriage, and Fig. 1590 shows respectively a longitudinal section and a plan.

The boat has end and side air cases *f*, *g*, *b*. A water-tight deck with relieving tubes *a*. Spaces beneath the deck longitudinally amidships of the boat are packed with cork, forming a portion of the ballast. The extra buoyancy is obtained by the air-cases.

The self-discharge of water is provided for by the relieving tubes *B*, for, as the water-tight deck is always slightly above the level of the water outside, any sea that is shipped must flow out through these tubes, which are furnished with very simple self-acting balanced valves, that afford no obstruction to the free egress of water, but, closing by the pressure of the sea outside, effectually prevent the admission of any. The actual time occupied by one of these boats in freeing it-

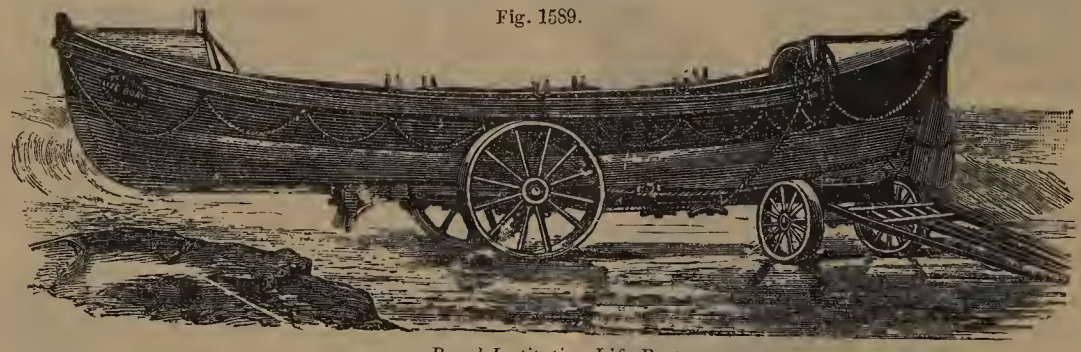
Fig. 1588.



British Life Boats.

self from water is about 30 seconds. A large portion of the ballast is composed of cork or wood. The really distinguishing feature of these boats is the property which they possess of self righting. The best proof of the safety of the boats is the fact that during the last 22 years the Institution has only lost from all causes, 29 persons from its own life boat crews, and many of these lives were lost by the men being crushed against wrecks, falling overboard, etc. The method by which this peculiar property is obtained is by attaching a heavy iron keel to the boat, and otherwise providing a sufficient weight of ballast, by giving a considerable amount of sheer, and by inclosing the bow and stern by air-tight chambers. These chambers have sufficient buoyancy to support the whole weight of the boat when upset, with the keel at a considerable height above the water; it is then floating on two points, with the ballast far above the center of buoyancy, thus forming an

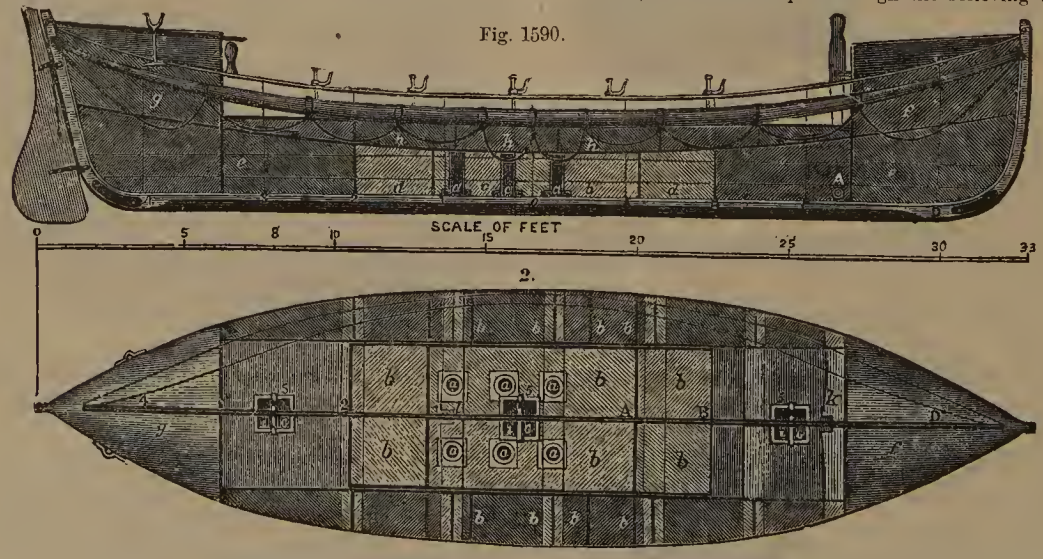
Fig. 1589.



Royal Institution Life Boat.

unstable equilibrium. In this position the boat cannot remain; and as soon as the keel falls to one side or the other of the center of gravity, the weight of ballast drags the boat round, the water escapes through the relieving tubes,

Fig. 1590.



Royal Institution Life Boat. (*Longitudinal Section and Plan.*)

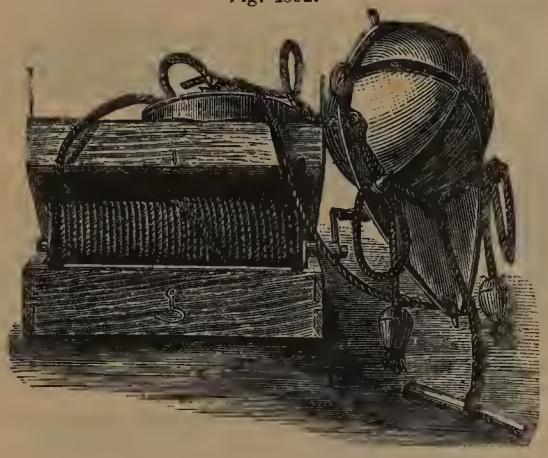
a, Delivering tubes; *b*, Air-cases; *c*, Well; *d*, Air-cases: *e*, Empty air-cases under deck; *f*, Fore air-compartment; *g*, After air-compartment; *h*, Air-cases; *k*, Mast-thwart; *s*, Scuttles for air

and she is again ready for service. The following are the requirement srequisite to insure self-righting: (1.) Ballast. (2.) Inclosed air chambers at the bow and stern, placed sufficiently above the center of gravity. (3.) Limited breadth of beam. (4.) Limited side buoyancy.

Life Buoy. One thrown to a man overboard.

The one in Fig. 1591 is Routourier's. It has two inflated canvas globes, a connecting strap, and winding-in line.

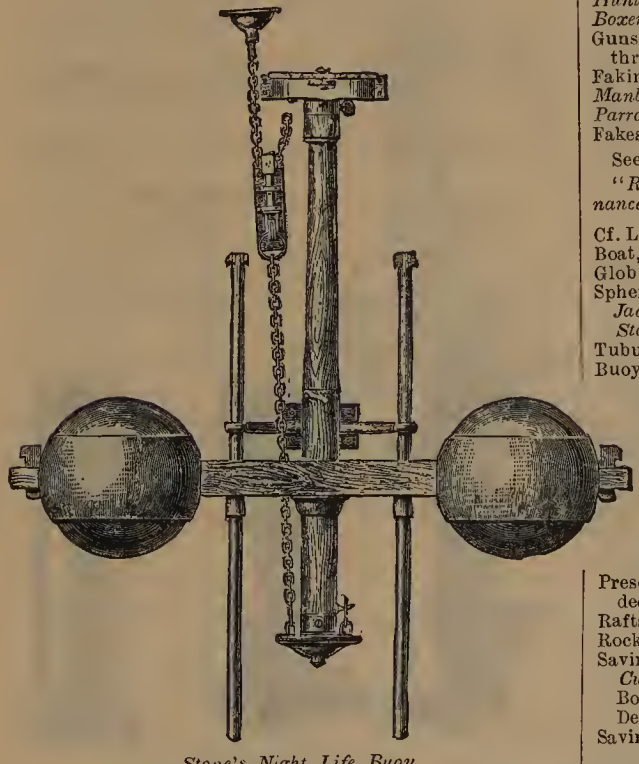
Fig. 1591.



Routourier's Life Buoy.

Fig. 1592 is Stone's improved form of Lieut. Cook's buoy (Br.). In this night life buoy, the act of throwing it overboard sets light to a port fire, which burns steadily on the surface of the water, and shows the situation of the life buoy to the party requiring its aid, as well as lighting the boat to the seaman in the water. This life buoy is in general use in the British navy.

Fig. 1592.

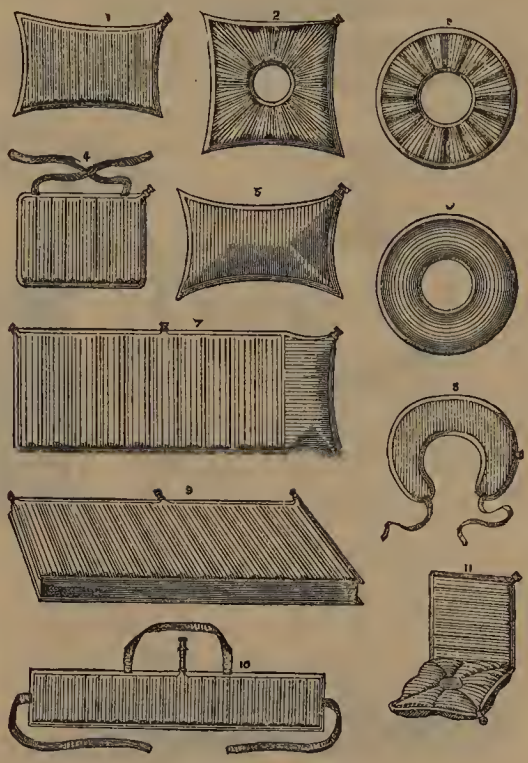


Stone's Night Life Buoy.

Life Pre-serv'er. An inflatable pillow, cushion, jacket, or what not. Fig. 1593 shows a number of forms.

Life-sav'ing Ap'pa-ra'tus. A lengthy and admirable report on life-saving apparatus, guns, projectiles, etc., by Lieut. D. A. Lyle, is to be found in "*Ordnance Report*," 1868, Appendix P, pp. 177–334, and Plate LIV.

Fig. 1593.



Life Preservers.

History of life-saving apparatus . . . . . "*Ordnance Report*," 1868, Appendix P., pp. 285–300.
Hunt's apparatus . . . *Ibid.*, p. 305 and Plate LI.
Boxer's life-saving rocket *Ibid.*, p. 314, and Plates XL., XLI.
Guns and projectiles for throwing shot-lines . *Ibid.*, Plates I. to XXX.
Faking boxes . . . . *Ibid.*, Plates XXXI. to XXXIV.
Manby's shot, etc. . . . *Ibid.*, Plate XXXVIII.
Parrot's projectile . . . *Ibid.*, Plate L.
Fakes . . . . . *Ibid.*, Plates XLVIII., XLIX.

See also ANCHOR SHOT; BARBED SHOT; GRAPPLE SHOT.

"*Report on the Manufacture of Life-saving Guns*," "*Ordnance Report*," 1879, * p. 270, with 7 plates.

Cf. Life Boat, *Atkin* . . "*Scientific American Sup.*," 192.
Boat, *Chapman* . . . * "*Scientific American Sup.*," 96.
Globular, *Manes* . . . * "*Manuf. and Builder*," ix. 185.
Spherical, *Manes* . . . * "*Scientific American*," xxxvii. 54
Jackson . . . . . * "*Scientific American Sup.*," 1568.
Stockwell . . . . . * "*Scientific American Sup.*," 458.
Tubular, Br. . . . . * "*Engineer*," xliv. 404.
Buoy, Pocket . . . . "*Scientific American*," xxxix. 192.
Preserver, *Beck* . * "*Scientific American*," xxxvi. 274.
Cavalry and equestrian's inflatable saddle cloth . . * "*Scientific American Sup.*," 1161
Delhommer . . * "*Scientific American*," xlii. 115.
Preserving cap. *McCarthy* . . . * "*Scientific American*," xxxv. 242.
Preserving stool. *Nash* . . . . * "*Scientific American*," xxxiv. 291.
Preserver, *Rose* . * "*Scientific American*," xlii. 294.
Preservers, stuffed with deer hair . . . . . "*Manuf. and Builder*," x. 232.
Rafts, "*Engineer*" . . "*Van Nostrand's Mag.*," xiv. 308.
Rocket, *Atkinson* . . . "*Scientific American*," xxxvi. 207.
Saving apparatus. *Cummerford* . . . * "*Scientific Amer.*," xxxix. 182.
Bow . . . . . "*Scientific American*," xl. 376.
Devices . . . . . "*Scientific American*," xxxiv. 87.
Saving app. U. S. Marine * "*Scientific American Sup.*," 575.
"*Scientific American Sup.*," 2778
Saving line shot, *Hunt* . * "*Scientific American*," xl. 376.
Saving mattresses . . "*Scientific American*," xl. 145.
Saving rocket, buoyant, Br. . . . . * "*Engineer*,," xlix. 70.
Saving vessel, *Stockwell* * "*Engineer*," xl. 395.
Saving app., cannon for line shot . . . . . * "*Engineer*," xlvii. 212.

See also LINE THROWING GUN, *infra*.

Article "*Porte-Amarres*," *Laboulaye's* "*Dict. des Arts et Manufactures*," iv., ed. 1877, has notices of *Manby*, *Delvigne*, *Tremblay*.

Life-sav'ing Suit. An inflatable dress to buoy up a swimmer or shipwrecked person.

Boynton's rubber life-saving dress is in two parts, tunic and pantaloons. The latter contains an air-chamber in each leg, which extends to the tops of the boots, while the waist is

Fig. 1594

Boynton's Life Suit.

girdled with a resisting steel band, on which is mounted a flange or ridge of heavy rubber. The jointure is made by lapping the tunic over the band, and a similar ridge drops into the groove formed. A belt thrown over the whole makes a tight joint. The tunic contains three air-chambers; one in the breast, back, and head respectively. When the latter chamber is inflated through the tube, it forms a pillow, raising the head of the occupant sufficiently to give him a complete range of vision. The suit is of delicate construction, and yet it will resist severe breakers and seas. The face is the only portion of the body exposed.

Fig. 1594 represents the swimmer in full outfit, and a sectional view to illustrate the construction.

Life Sig'nal. A provision on a life-saving buoy by which an inextinguishable light is given as soon as the buoy touches the water.

These chemical lights are now made in a variety of forms, and serve a useful purpose in giving a bright light upon the water when thrown overboard. One of the best of these contains chemicals that will not burn at any application of heat, but touched by water will evolve a bright flame. A small cylindrical box, ending above in a soft copper nib, is weighted below to keep it upright in the water, and filled with phosphate of calcium. When thrown into the sea, after the copper nib has been cut off, the water penetrates into the box, and the phosphureted hydrogen evolved escapes through a perforated tube leading to the open nib in a brilliant jet of light. Rain and spray only increases its brilliancy. Lieut. Cook's safety buoy is described under Buoy, p. 407, "*Mech. Dict.*" See also Fig. 2925, page 1301, *Ibid.*

Life Slide. See Life and Current Slide; Current Slide. Fig. 748, p. 236, *supra.*

Lift. 1. The pump stock, or a portion thereof, of a deep well-pump. Perhaps especially one belonging to the Cornish system.

Fig. 1595 shows a portion consisting of a working barrel (11′), a door piece (6′) fitted with valve-seat and valve, an egg-ended wind-bore (9′) and the door-piece which has lugs for suspending it when the valve is to be examined.

2. A hand-hold attached to a window or window-blind, by which to raise or lower.

Cf. Lift Hydraulic on canals . . . . . "*Van Nostrand's Mag.*," xiv. 92.
Morris and Essex canal Fig. 2665, p. 1176, "*Mech. Dict.*"
Great Western canal. Br. Fig. 2932, p. 1304, "*Mech. Dict.*"

Fig. 1595.

Working Barrel of Cornish Pump.

Lifting Bridge,
Scheldt, Antwerp . . * "*Engineering*," xxv. 139.
Brussels . . . . . Fig. *a*, 2935, p. 1305, "*Mech. Dict.*"
Peronnet . . . . . Fig. *b*, 2935, p. 1305, "*Mech. Dict.*"
Bascule . . . . * "*Mech. Dict.*," p. 241, Figs. 588, 489.
Lifting chock for threshers, *Clayton & Shuttleworth* . . . . . * "*Engineer*," xlii. 57.
Lift, double, *Weston* . * "*Iron Age*," xxiii., March 20, p. 9.
Lifting Jack, *Cornell* . * "*Scientific American*," xxxiv. 166.
"Magic" . . . . . * "*Iron Age*," xxii., Sept. 5, p. 9.
Rowland . . . . . * "*Scientific Amer.*," xxxviii. 297.
Smith . . . . . * "*Scientific Amer.*," xxxviii. 355.
Vibert . . . . . * "*Scientific American*," xxxiv. 274.

Lift'er. 1. The device on top of a drop press by which the hammer is raised, and which becomes detached to allow the hammer to drop. See Drop Press, "*Mech. Dict.*"

2. A form of extractor for tubing or boring bars in oil-wells. See Plate LXXIV., p. 2758, *Ibid.*

"*American Manufacturer*" . . . May 30, 1879, p. 16.

Lift'ing-back Saw. (*Surgical.*) One which has a hinged back to stiffen the blade when in use.

Lift'ing Gate. 1. A farm gate vibrating upwardly, being hinged to a horizontal pintle on the post. See instances on p. 958, "*Mech. Dict.*"

2. A form of water-gate used in the penstocks of water-wheels.

Lift'ing Jack. A portable contrivance for raising weights. See pages 1305, 1306, "*Mech. Dict.*"

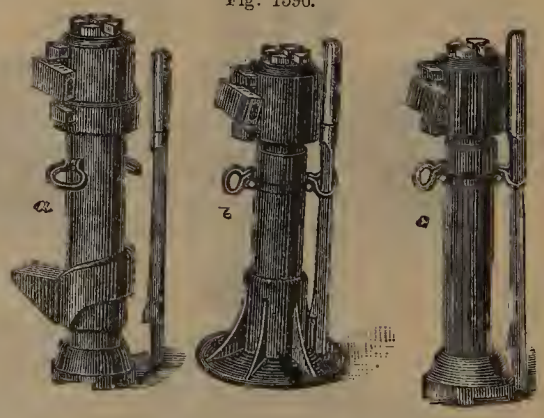
Among other forms may be found the following, which see: —

Bottle jack.	Screw jack.
Hydraulic jack.	Wagon jack.
Lever jack.	Jack screw.

See list of jacks on p. 1208, "*Mech. Dict.*"

Fig. 1596 shows several forms of hydraulic lifting jacks.

Fig. 1596.



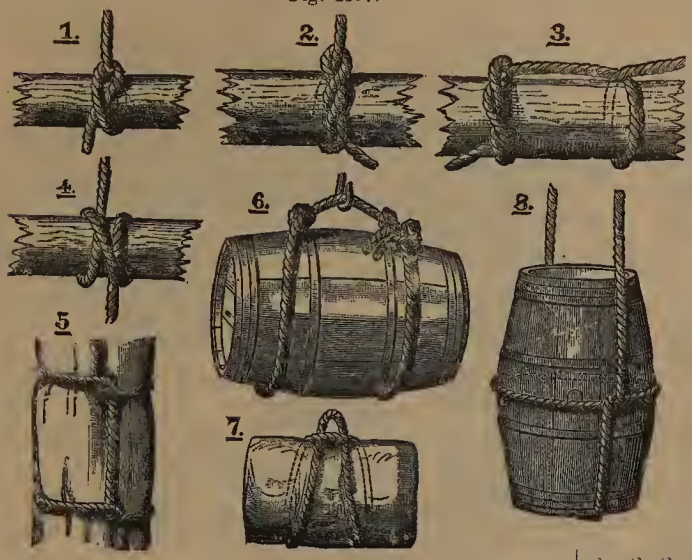
Hydraulic Jacks.

a. Lifting jack with low-down claw.
b. Wide base jack.
c. Ordinary hydraulic jack.

Lift'ing Hitch. A mode of slinging an article by a rope so that the object may be raised.

Fig. 1597 shows a number of hitches appropriate to the objects.

Fig. 1597.

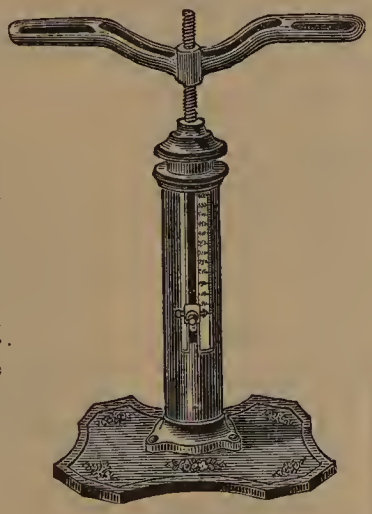


Lifting Hitches.

1. Half-hitch.
2. Timber hitch.
3. Half-hitch and timber hitch.
4. Clove hitch.
5. Hammock hitch.
6. Cask sling.
7. Bale sling.
8. Butt sling on end.

Lift'ing Ma-chine'. A form of dynamometer used in ascertaining the strength of a person in lifting; or by gradually increasing the load, to develop greater strength by exercise.

Fig. 1598.



Lifting Machine.

See also EXERCISING MACHINE; HEALTH LIFT.

Lift Jig'ger. (*Nautical.*) A light tackle for swaying on the lifts of the yards.

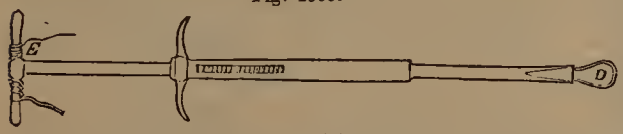
Lift Latch. A lock in which the latch is lifted, not slipped.

Li-ga'tor. (*Surgical.*) An instrument to place and fasten a ligature.

See Fig. 2944, p. 1308, "*Mech. Dict.*"

See also "*Écraseur*," Fig. 1823, p. 773, *Ibid.*, and Fig. 919, p. 292, *supra.*

Fig. 1599.



Dr. Crooker's Ligator.

See also Artery Ligators, pp. 26-28, Part I. *Tiemann's "Armamentarium Chirurgicum."*

Also Ovarian Ligators, pp. 92, 93, Part III., *Ibid.*

Fistula and Hemorrhoid Ligators, pp. 122, 123, Part III., *Ibid.*

Fig. 1600.

Helmuth's Elastic Ligature Carrier.

Dr. Crooker's ligator for the gradual removal of tumors is shown in Fig. 1599. The spring is retained in a compressed state, until the ligature has been passed around the tumor, and its free ends secured to the cross-bar; it is then released, and the removal of the tumor is accomplished gradually and with little danger of hemorrhage.

Lig'a-ture Car'ri-er. Ligature carriers, knot-tyers, and ecraseurs are shown in Fig. 2944, p. 1308, "*Mech. Dict.*"

Helmuth's elastic ligature carrier, adapted for the treatment of complete or incomplete fistula, has two buttons, *A B*, Fig. 1600, close up to the handle of the instrument. By pushing forward the button *A*, the blunt end of the instrument, as seen at *F*, opens. The elastic ligature is then put upon the stretch, and, while thus drawn out, is slipped into the notch, and the button *A* drawn back to its place, and the needle (if the case is one of complete fistula) is ready for use.

If the fistula be incomplete, the blunt end is passed firmly up to the end of the sinus, the button *B* is pushed forward, which protrudes the sharp point *D*; in other words, transforms the blunt into a sharp point. The fistula is then made complete by piercing the tissues; as soon as this is done, the point is retracted again within its sheath, thus leaving a rounded extremity in the rectum. By elevating the handle with the left hand, and drawing the blunt end down by means of the index finger inserted within the rectum, the ligature is brought out at the anus, taken hold of and held, while the button *A* is pushed up, which entirely liberates the thread. The instrument is then withdrawn, the ends of the ligatures are passed through a leaden ring, which is slipped into position and clamped by forceps.

Light. See the following references: —

From mechanical force.	
Barker	"*Scientific American*," xxxiv. 181.
Lighting devices . . .	"*Iron Age*," xix., May 3, p. 18.
Apparatus, *Dorscher* . .	* "*Scientific American*," xli. 339.
Lime light	"*Iron Age*," xxi., May 9, p. 24.
	"*Scientific American*," xxxviii. 58.
Electro chemical . .	"*Scientific American*," xxxvi. 200.
Index of refraction.	
Mode of determining .	"*Scientific American Sup.*," 1366.
Intermittent light.	
Sir W. Thomson . .	"*Van Nostrand's Mag.*," xiv. 107.
Light registering appa.	
Prof. Roscoe . .	"*Scientific American Sup.*," 460.
Oxygen apparatus . .	* "*Scientific American*," xxxix. 73.
Oxygen retort	* "*Scientific American Sup.*," 1227.
Oxhydrogen light . .	"*Scientific American Sup.*," 93.

Light'er Staff. (*Grain Mill.*) A lever supporting and controlling the adjustable end of the bray-plank or bridge-tree, to which it is connected at one end by a stirrup while its other end receives the lighter screw, or sometimes, a counterbalance weight.

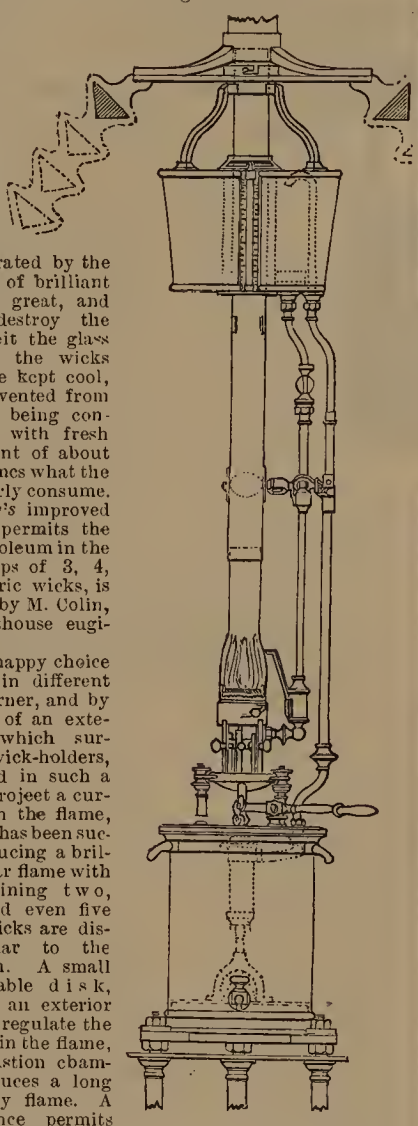
Light'house. The new Eddystone lighthouse is to be erected on the south rock of the group, about 120′ south of the present lighthouse, erected by Smeaton in 1757. The present lighthouse manifests no sign of weakness, but the "House Rock" on which it stands has been worn and probably undermined by the waves.

The Eddystone lighthouse is described on p. 1311 of the "*Mech. Dict.*" The new structure will be built to contain a light of more extensive radius and greater power. The old tower is 72′ above the level of high water; the new one is designed to be 130′ above the level of any spring tide, so that no matter what storm may rage, the light will be in no danger of being eclipsed. It will have a range of 17½ miles, and is expected to overlap the electric light at the Lizard. Beside this, the tower will be considerably enlarged, giving nine rooms in place of the existing four, thus adding to the comfort and convenience of the keepers. The structure complete will cost £70,000, and be completed in four years. The same process of dovetailing the stones will be adopted, but granite is substituted for Portland stone.

The abundance and cheapness of petroleum oil, and the whiteness and brilliance of the flame it gives when consumed in properly constructed lamps, more than twenty years ago suggested its use for light-houses. The colza-oil lamps in use in light-houses have one wick for reflectors and small dioptric apparatus, and two,

three, four, and even five wicks adapted to the different orders of dioptric apparatus, and the flames developed in these lamps are of greater size and brilliance than that of the four-wick lamps; for example, being nearly 4″ in diameter, by about the same in height, emitting a light equal to nearly 260 standard sperm candles. The heat generated by the four cylinders of brilliant flame is very great, and would soon destroy the burner and melt the glass chimneys, but the wicks and burners are kept cool, and the oil prevented from volatilizing by being constantly flooded with fresh oil to the extent of about three or four times what the lamp can properly consume.

Fig. 1601.



Funck's Float Lamp.

Captain *Doty's* improved burner, which permits the burning of petroleum in the lighthouse lamps of 3, 4, and 5 concentric wicks, is thus described by M. Colin, a French lighthouse engineer: —

"It is by a happy choice of proportion in different parts of the burner, and by the application of an exterior cylinder which surrounds the wick-holders, and is arranged in such a manner as to project a current of air upon the flame, that Capt. Doty has been successful in producing a brilliant and regular flame with burners containing two, three, four and even five wicks. The wicks are distributed similar to the Fresnel system. A small central adjustable disk, combined with an exterior air cylinder, to regulate the currents of air in the flame, forms a combustion chamber which produces a long and very lively flame. A simple appliance permits the application of his system of burners to the ordinary overflow lamp, *i. e.*, the mechanical and moderator lamps."

This invention at once places within the reach of lighthouse authorities lamps which do not require any structural rearrangement of the apparatus or lamps at present in use; new burners only require to be screwed or soldered on to the existing lamps, and the lighthouse management goes on as formerly, but with this difference, that the flames of the Doty burner show greater illuminating power.

Funck's float lamp for lighthouses is shown in Fig. 1601.

The float is in the chamber which is seen parallel with the burner and regulates the supply which descends from the elevated oil-chamber. The overflow passes into a lower chamber from whence it is again pumped into the elevated chamber, by means of a pump, the handle of which is shown protruding to the right.

Cf. Architecture.

"*The Builder*" . .		"*Van Nostrand's Mag.*," xviii. 17.
Burners		"*Iron Age*," xix.. March 8, p. 18.
"Chickens," rock . .	*	"*Engineer*," xlvii. 356.
Chipiona, Spain . . .	*	"*Scientific American Sup.*," 2699.
Dhu heartach, Scotland		"*Scientific American Sup.*," 373.
Eddystone (new), . .	*	"*Engineering*," xxiv. 209.
		"*Iron Age*," xxiv., Sept. 4, p. 5.
		"*Van Nostrand's Mag.*," xix. 379.
		"*Scientific American*," xli. 145.
Maj. Elliot's Rept. . .	*	"*Van Nostrand's Mag.*," xiv. 97.
Eng'ing. "*Engineer*," .		"*Van Nostrand's Mag.*," xxi. 205.
Sein near Finisterre, Fr. .		"*Scientific American Sup.*," 1125.
Illuminating		"*Scientific American*," xxxv. 154.
Illumination, Engl. . .	*	"*Scientific American Sup.*," 2838.
On lighthouses, *Wigham*	*	"*Engineering*," xxvi. 185.
Little-Basses, Ceylou .	*	"*Scientific American Sup.*," 945.
Iron, Mexico		"*Scientific American*," xlii. 80.
Rennie	*	"*Engineer*," xlvii. 353.
Roche Douvres, Fr. . .		*Laboulaye's* "*Dictionnaire*," iii *Cap. Serrurerie*, Fig. 101.
Souter Point, Engl. . .		"*Scientific American Sup.*," 945.
Smeaton	*	"*Engineer*," xlvii. 353.
Stevenson	*	"*Engineer*," xlvii. 353.
Tampico	*	"*Iron Age*," xxv., March 25, p 1.
Stones, *Weymouth*, Br. .	*	"*Engineering*," xxx. 399.
Ships and shore Teleg. Communication . .		"*Telegraphic Journal*," iv. 113
Walder		*Laboulaye's* "*Dictionnaire*," iii. *Cap. Serrurerie*, Fig. 100.

Cf. Elliot's Report on "*European Lighthouses.*"
"*Lighthouses,*" by David Stevenson, Edinburgh.

Light Met'al. One having a specific gravity less than 5: water being 1.

Aluminium	2.6.
The metals of alkaline earths: —	
Barium	4.
Strontium	2.5
Magnesium	1.74
Calcium	1.6
The lightest are: —	
Potassium	0.86
Sodium	0.8
Lithium	0.6
Rubidium	?
Cæsium	?

Light Mod'e-ra-tor. (*Optics.*) Two circular pieces of flat glass are mounted on a stand, one blue and the other red, so combined as to give a white light when using the microscope with artificial light.

Light'ning Rod.

See arrester, *Eggington*	*	"*Telegraphic Journal*," v. 192.
Investigations of, *Planté*	*	"*Scientific Am. Sup.*," 971, 1052.
Conductor.		
"*English Mechanic*" .		"*Van Nostrand's Mag.*," xxii. 102.
Galvanometer for testing	*	"*Telegraphic Journal*," iv. 279.
Discharger, *Rymer Jones*	*	"*Telegraphic Journal*," vi. 489.
Protector, Telegraph .	*	"*Scientific American Sup.*," 14.
Vases	*	"*Scientific American Sup.*," 456.
	*	"*Telegraphic Journal*," iv. 79.
Rods		"*Scientific American Sup.*," 6.
	*	"*Scientific American*," xxxv. 164.
Rod discharging point, *Weston*		"*Scientific American*," xxxiv. 230.
Rods, on, *Kirchoff* . .		"*Van Nostr. Mag.*," xxiii. 491.
Rod, nickeled		"*Scientific American Sup.*," 48.
Rods, principles of . .		"*Scientific Amer.*," xxxvi. 385.

Light Reg'is-ter-ing Ap'pa-ra'tus. An automatic device by Prof. Roscoe to keep a record of the amount of light that falls at any particular spot during small fixed intervals.

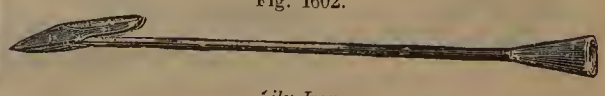
Clockwork drives the apparatus, photographic paper is the sensitive agent used, and by mechanical arrangements certain small portions of the paper are exposed to the action of light for fixed intervals, which can be regulated at pleasure. The tinted photographic paper is compared by the eye with a conventional scale of tints.

Lig'nose. A Silesian blasting powder made of woody fiber charged with nitro-glycerine.

It is very light; burns slowly in a loose state; does not explode in contact with open fire; is three times as strong as an equal weight of black blasting powder, and less than one third the price. Mentioned in the "*Deutsche Industrie Zeitung.*" Made at Kieltsh by Barou von Trutzschhler Falkenstein.

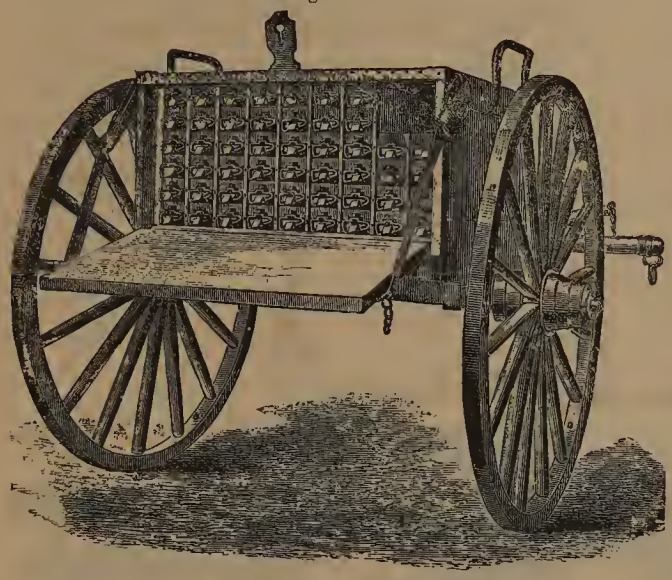
Lil'y I'ron. (*Fishing.*) The harpoon head, detachable from the stem, used in capturing swordfish. See also HARPOON.

Fig. 1602.



Lily Iron.

Fig. 1603.



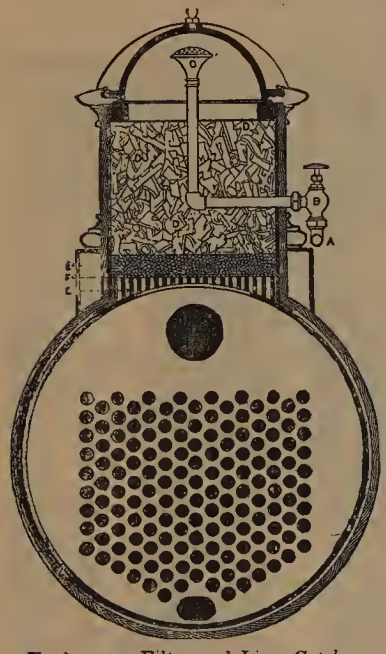
Limber for Gatling Gun.

Lim'ber. The ammunition carriage to which the trail of a field-piece is attached when in marching order.

Fig. 1603 shows the limber for the Gatling gun. The drawers hold cases of ammunition, 20 or 40 in a case; the case is slipped into the feed hopper of the gun, and the cartridges fall into the loading grooves of the gun as they successively present themselves when the barrels are rotated.

Lime Catch'er. A device placed between a feed-water pump and the steam boiler to intercept the lime.

Fig 1604.



Feed-water Filter and Lime Catcher.

The device shown is in use on the Illinois Central Railway, and its purpose is to prevent the deposition of scale.

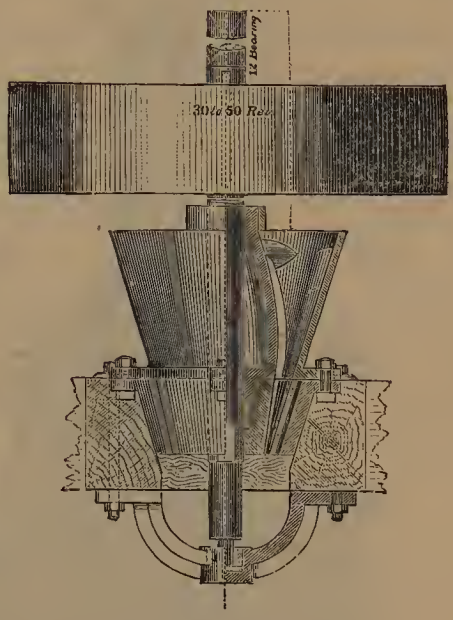
Instead of admitting the feed-water into the boiler in the usual manner (that is, on the side of the boiler, below the water level), the feed-water pipes are carried from the pumps, or injectors, to the top of the forward dome, either inside or outside of the dome, and deliver the water near the top of the dome from a rose, *C*, in the form of spray or thin sheets. From this point it falls into the body of the boiler by its own gravity, and in its descent is compelled to pass over and among pieces, *D D*, of metal, wood, charcoal, tile, oyster shells, etc., which are placed in the dome and are heated to the same temperature as the steam which surrounds them, and upon which the lime, magnesia, and other mineral impurities in solution in the water will deposit themselves. These pieces of metal, etc., are supported by a grating, *G*, over which is laid, if necessary, a piece of wire netting, *F*, to prevent the charcoal, *E*, from being washed through into the boiler.

The pieces of metal, etc., are renewed occasionally.

See also Feed Water Heater, Figs. 1000–1011, pp. 328, 329, *supra*.

Lime Crack'er. A mill for rough-grinding crude plaster and calcined limestone. The teeth are of chilled iron; those in the lower part of the pot are made in sections, which can be renewed separately when they wear out. The core is made in sections, also renewable. Used in cement works. With a motion of 30 revolutions per minute, a mill will reduce hard calcined water lime to a fineness suitable for grinding at the rate of 60 barrels per hour.

Fig. 1605.



Lime and Plaster Cracker.

See also Cement Mill, Fig. 575, p. 183, *supra*; Fig. 1199, p. 510, "*Mech. Dict.*"; Mortar Mill, Figs. 3230, 3231, p. 1480, *Ibid.*, etc.

Lime Ex-tract'or. See Feed Water Heater, pp. 328, 329, *supra*; Lime Catcher, *supra*.

Lime'-glass. (*Glass.*) Known in England as *white* glass; not to be confounded with *flint*-glass, which has lead in it.

Bohemia is especially celebrated for its *white* glassware, making all articles usually made in *flint*-glass in England. The latter is the whiter and more brilliant; the *lime-glass* is the harder, and is blown into wooden molds. It is invaluable in the laboratory. Recipe: —

Pulverized quartz	100
Carbonate of potash	28 to 32.
Slaked lime	13 to 15.
Oxide of manganese	1
Arsenic	3

Saltpeter, borax, red lead, sometimes enter into the mixture in small proportions.

The French lime-glass, also known as *half-crystal*, is composed as follows: —

Sand	200
Carbonate of soda	66
Lime	50

Or —

Sand	3,000
Sulphate of soda	170
Slaked lime	75
Ground charcoal	10

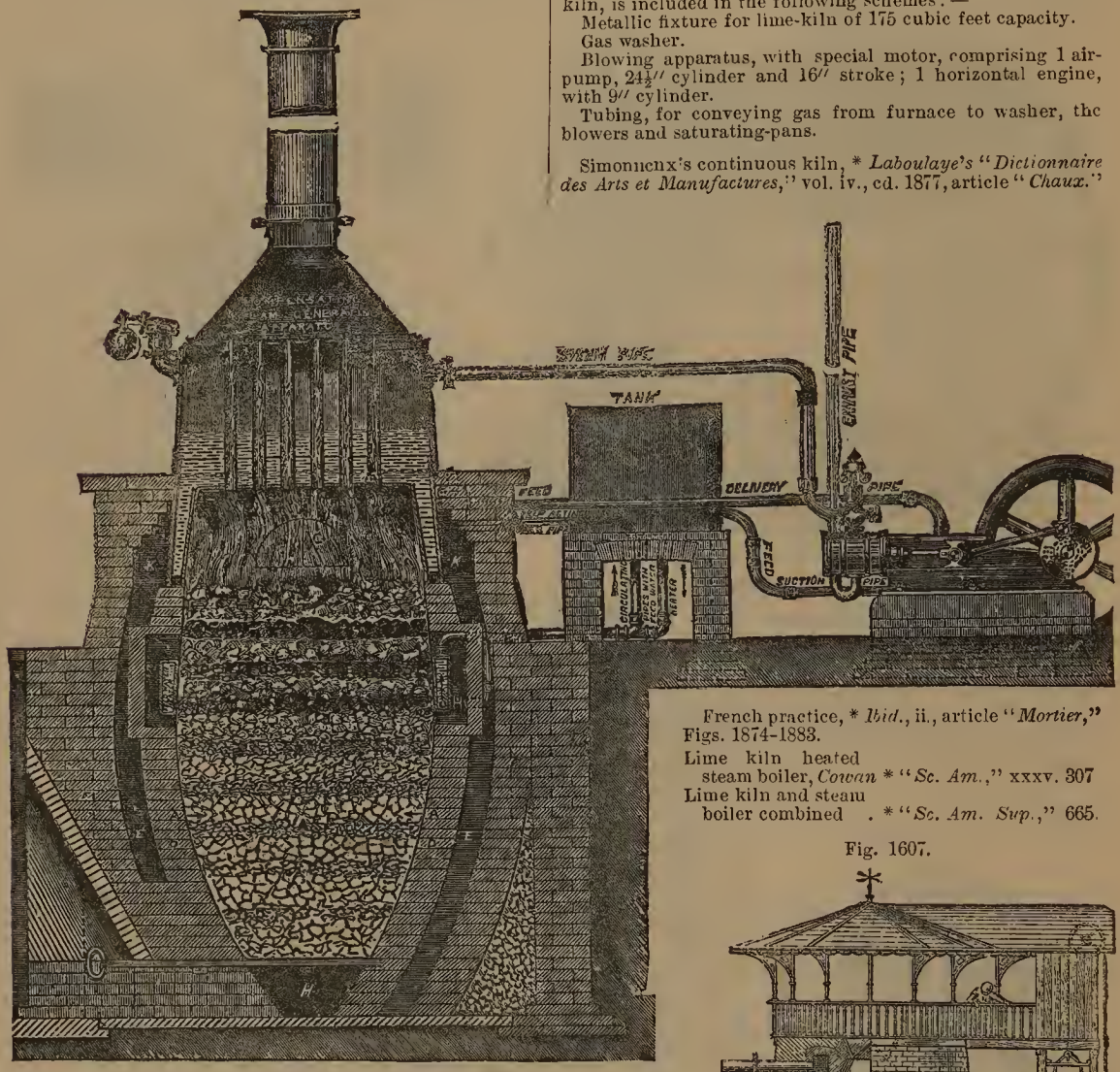
A few hundredths of red lead are sometimes added.

Lime Kiln. Additional to what has been given on pp. 1319, 1320, "*Mech. Dict.*," some instances may be given of the calcination of lime combined with steam boiler heating, and the production of carbonic acid for use in sugar houses.

Cowan's (Br.) steam generating apparatus, combined with a kiln for calcining limestone, is shown in Fig. 1606.

The kiln is worked on the continuous principle, with coal and limestone alternately, and in regulated quantities. The escaping heat generates steam in boiler, which is partly jacketed around the kiln, and partly consists of a dome with vertical flues.

Fig. 1606.



Combined Lime Kiln and Steam Boiler.

A. Kiln furnace.
B. Boiler.
C. Feed water heater.
D. Fire-brick lining.
E. Air space or sand backing.
F. Masonry
G. Furnace door.
H. Draw hole for removing lime.
K. Flue round boiler.

The calcination of limestone and chalk in kilns, for the production of carbonic acid, for use in the manufacture of beet sugar, is a prominent feature in European *sucreries*.

M. Derosne was the first to suggest quick-lime in the purification of the beet juice. His method was based upon three principal points: (1) the use of caustic lime; (2) the use of alum; and (3) the use of alcohol. The lime he adds to the fresh juice, of which he succeeded in expressing 63 per cent. of the weight of the root. The proportion added was 0.24 gram per liter of juice. After the addition of lime in a thick milk the juice was rapidly brought to boiling and the scums removed as they formed. The juice was then separated from the sediment, which settled and concentrated. It was then purified with alum and blood, and farther treated in the usual way. The proportion of sugar extracted by this method is stated to have been 4½ per cent., and was the highest result that had yet been attained. The beets from which this high yield was obtained were of the white Swedish variety, while the beets of the plain of Aubervillier did not yield as much by 2½ per cent.

Fig. 1607 shows a limestone calcining furnace specially devised for *sucreries*, and made by Chrétien, of Paris. It has steam elevator for the limestone, and a tube at the summit to conduct the carbonic acid to the pans in which the beet juice is saturated with the gas. This is described under CARBONATION PAN, p. 163, *supra*.

See also *Dr. McMurtrie's* "*On the Sugar Beet, and the Manufacture of Sugar Therefrom*," Special Report, No. 28, Department of Agriculture, Washington, 188[illegible]

The plant for the purpose, to be added to the ordinary kiln, is included in the following schemes: —

Metallic fixture for lime-kiln of 175 cubic feet capacity.

Gas washer.

Blowing apparatus, with special motor, comprising 1 air-pump, 24½″ cylinder and 16″ stroke; 1 horizontal engine, with 9″ cylinder.

Tubing, for conveying gas from furnace to washer, the blowers and saturating-pans.

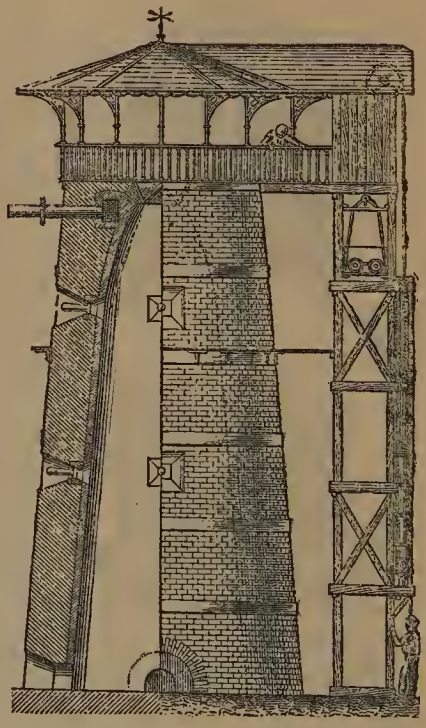
Simonneux's continuous kiln, * *Laboulaye's* "*Dictionnaire des Arts et Manufactures*," vol. iv., ed. 1877, article "*Chaux.*"

French practice, * *Ibid.*, ii., article "*Mortier*," Figs. 1874-1883.

Lime kiln heated steam boiler, *Cowan* * "*Sc. Am.*," xxxv. 307

Lime kiln and steam boiler combined . * "*Sc. Am. Sup.*," 665.

Fig. 1607.



Lime Kiln for Beet Sugar Factories.

Lime Light. The Drummond light has been described at Fig. 1788, p. 757, "*Mech. Dict.*"

Fletcher's lime light consists of a block of lime, incased in a cylinder of porous ganister, and subjected to a flame from a Bunsen. At an opening in the pottery envelope the light is emitted. The ganister cover is made of refractory clay 1 part; sawdust, 6 parts; burned: this makes a very porous material, like pumice; an excellent non-conductor of heat.

Line. 1. (*Fishing.*) *a.* The thread, twine, or cord used in baited-hook fishing. Known by vari-

ous names indicative of size, quality, material, make, purpose, etc.; such as: —

Bottom set line.	Set line.
Braided silk.	Silk line.
China grass.	Silk-worm gut.
Cork line.	Silver gimp.
Cotton line.	Snood.
Float line.	Squid line.
Gut line.	Spilliard.
Hand line.	Surface line.
Harpoon line.	Tapered silk.
Land line.	Throwing line.
Linen line.	Toggle line.
Loaded line.	Trawl line.
Plaited line,	Trot line.
Rigged line.	Twisted silk line.
Seine line.	Waterproof.

b. Of a seine: —

The *cork* line, or line of floats on the upper edge.

The *toggle* line, which in some seines runs along the line of leads.

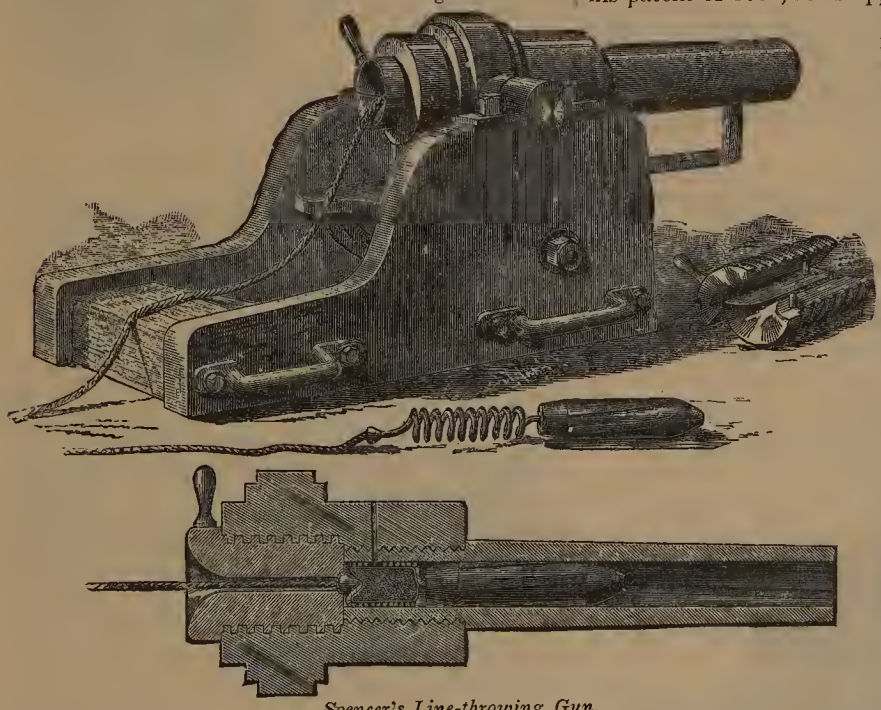
The *land* lines, which pass from the ends of the seine to the sheave blocks on shore.

2. Mason's line, chalk line, etc.

Lin'ear Knife. (*Surgical.*) A delicate, sharp-pointed knife used in making the incision in operation for cataract. *Graefe's* and *Baader's*, straight and angular with the blade, are in *Tiemann's* "*Armamentarium.*"

Line Hook. (*Whaling.*) A hook for catching the harpoon line.

Fig. 1608.



Spencer's Line-throwing Gun.

Line-throw'ing Gun. A gun for throwing a line to vessels stranded or in distress off shore.

Fig. 1608 is Spencer's breech-loading line-throwing gun, which is mounted in the usual way, but has an axial aperture in the screw breech-plug for the passage of the line, which is attached by a spring to the base of the projectile to prevent the parting of the line at the instant of firing. The breech-plug is in two parts, divided longitudinally, to obviate reeving the line through the hole. The tail of the cord is attached to a life-line lying faked in a box near by. See FAKE, Fig. 1000, p. 526, *supra*. See also ANCHOR SHOT, Fig. 61, p. 33, *supra*; GRAPPLE SHOT, Fig. 1270, p. 421, *Ibid.*

Lin'ing Felt. A fabric of hair, or hair and asbestos, which may be saturated with a lime cement, and used as a non-conducting covering for steam boilers and pipes.

A mixture of fiber, animal or mineral, with cement wash, applied with the brush for the same purpose.

A felt inserted in a partition or siding, as a deadener of sound or non-conductor of heat.

Lin'ing Nail. A sharp upholstering nail with semi-spherical head, brass or nickeled.

Link Mo'tion. See * p. 1824, "*Mech. Dict.*"

Link-block, locomotion, *Alexander* . * "*Sc. Amer.*," xxxv. 230.
Link motion, *Marshall*, Br. . . . * "*Eng'ng*," xxviii. 25.
On the link motion, *Smith* . . * "*R. R. Gaz.*," xxiii. 2.

Peaucillier was the first to discover that a straight line can be accurately described by a combination of links. See his parallel motion. See Fig. 3548, p. 1630, "*Mech. Dict.*"

Lint. 1. (*South.*) Ginned cotton before baling.

2. (*Fishing.*) A fisherman's name for the netting of a pound or seine.

3. (*Surgical.*) Raveled or scraped linen. See p. 1325, "*Mech. Dict.*"

Lip. The helical blade on the end of an auger to cut the chip. The *spur* makes the circumferential incision.

A lip auger has *pod* and *lip*; in contradistinction to the *screw*-auger.

Lip Hook. (*Whaling.*) A grapnel for catching in the lip of the whale, to tow it to the vessel.

Lip Pro-tec'tor. (*Dentistry.*) A saddle-shaped shield laid upon the lip to protect from abrasion or pinching during dental operations.

Liq'uid Bear'ing. Described by Bramah in his patent of 1802, for stepping vertical shafts. He went so far as to perform the vertical adjustment of the cutter spindles of his planing machine by pumping liquid into the step.

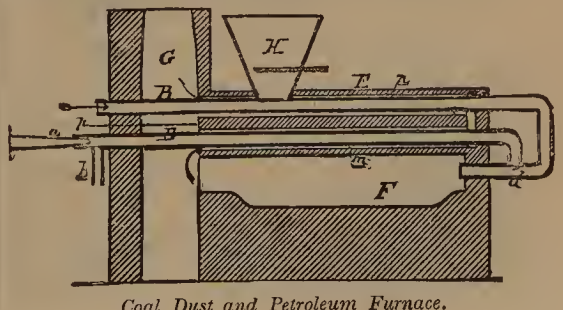
See JOURNAL BEARING, Fig. 1499, p. 516, *supra*.

See also PALIER GLISSANT; HYDRAULIC PIVOT: WATER-BEARING, "*Mech. Dict.*"

Liq'uid Fu'el Fur'nace. A furnace utilizing petroleum or paraffine as the inflammable agent. (Fig. 1609.)

One form is shown in Fig. 2965, p. 1325, "*Mech. Dict.*" *Caldwell's* coal dust and petroleum furnace is adapted as a puddling or heating furnace, through the roof *E* of which, as well as through the chimney *G*, pass the two pipes *B* and *D*, the former for admitting air under pressure, and the latter for receiving a jet of steam from a nozzle, *a*, the jet inducting petroleum from an adjoining reservoir through the branch *b* into the pipe *D*. Both of the pipes *B* and *D* communicate with a short pipe or nozzle, *d*, which projects into the interior *F* of the furnace at the front end of the same.

Fig. 1609.

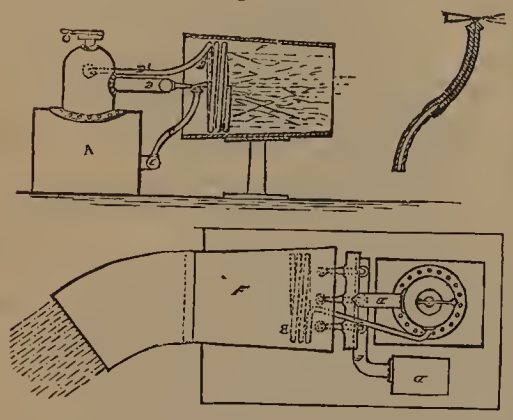


Coal Dust and Petroleum Furnace.

With the pipe *B* communicates a hopper *H* for containing coal-dust, more or less of which can be admitted to the pipe by means of a sliding damper. The petroleum injected into the pipe *D* in the form of spray by the steam-jet assumes a gaseous form before it reaches the nozzle *d*, where it unites with the supply of compressed and heated air which creates an intense heat in the furnace, and consumes the coal-dust which arrives by the air-pipe *E*, and is injected therewith into the furnace chamber *F*.

Fig. 1610 is Ramsden's hydro-carbon furnace (Br.), which is on the principle of the atomizer. Steam from a boiler is

Fig. 1610.



Hydro-carbon Furnace.

discharged in the form of spray from the outlets of horizontal tubes across the mouths of vertical tubes *c*, the lower ends of which are in a tank of petroleum. A vacuum is produced in the hydro-carbon tubes in the manner familiar in atomizers, and the consequence is a mingled spray of steam and hydro-carbon vapor which is conducted beneath the boiler.

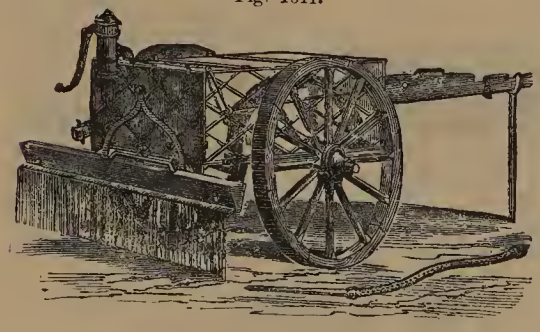
Blast . . . . . * "*Sc. Amer. Sup.*," 47.
Caldwell . . . . . * "*Sc. Amer. Sup.*," 125.
Ramsden . . . . . * "*Sc. Amer. Sup.*," 125.
Paper on, *Dickerson* in "*N. Y. Sun*" "*Sc. Amer. Sup.*," 3784.

See also PETROLEUM FURNACE, *infra*, and "*Mech. Dict.*," p. 1374.

Liq'uid Ma-nure' Cart. A vehicle for conveying liquid fertilizer and showering it upon the ground.

Fig. 1611 is a French form, made by *Bodin*, of Trois-Croix, Rennes. It is provided with a pump for filling the reservoir from cisterns in the barnyards or stables.

Fig. 1611.



Bodin's Liquid Manure Cart.

A British form is shown at Fig. 2919, p. 1326, "*Mech. Dict.*"

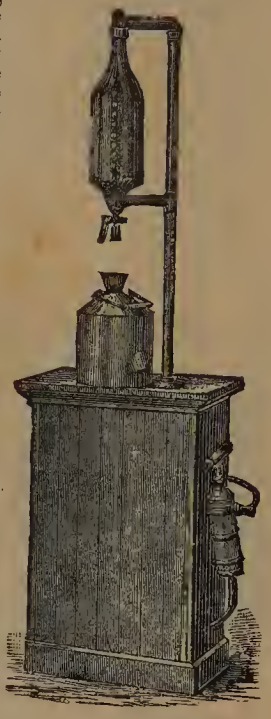
See also IRRIGATOR, *supra*.

Liq'uid Meas'ure. Liquid meters of several forms are shown on p. 1327, "*Mech. Dict.*"

See also WATER METER, Figs. 7110–7119, pp. 2740–2742, *Ibid.*, and SPIRIT METER, Figs. 2426–2429, pp. 2227–2278, *Ibid.* Also MEASURING APPARATUS; MEASURING FAUCET; MEASURING FUNNEL, pp 1413, 1414, *Ibid.*, and list under MEASURING APPARATUS, etc., *infra*.

Fig. 1612 shows *Wilkinson's* oil-tank with hand-pump which discharges into a glass vessel graduated to quarts, pints, etc. When the stop-cock is opened to draw off the fluid, a valve is also opened, and air is admitted to the top of the receptacle. When the measure is being filled by pumping the fluid into it, the air will open the upper valve and escape, the valve afterwards closing and preventing evaporation.

Fig. 1612.



Oil Can and Liquid Measure.

Liq'uid Weigh'er. A device in which a vessel is placed on a scale beneath a faucet, weights in the other scale representing the quantity required and the tare of the vessel. As the scale descends it trips a lever and turns off the spigot. —*Watts.*

Lis'sa-jou's Curves. The method of combining rectangular vibrations to form beautiful and instructive figures consisted in the first place of a pen connected with a pendulum swinging in one plane, and tracing lines upon a platform which reciprocated in a plane at right angles to that of the pen pendulum.

Next came a pen connected with two pendulums swinging in planes at right angles to each other, the tracing being a line, the result of the two impulses.

Shifting to the merely visual; two tuning-forks carrying small mirrors and vibrating at right angles to each other, threw pencils of light upon a screen and it was soon seen, though not unexpected, that the consonances and dissonances of sounds were admirably shown by the optical method, visible in an auditorium.

In the original method the dying action of the pendulums as they sank to rest diminished the amplitudes of the curves; differences in their rates curiously complicated the curves described; the center of gravity and therefore the time of oscillation of the pendulums being adjustable to any required amount, the proportions between the vibrations of the two could be brought to any desired ratio to represent harmony, unison, discord, or indeed to illustrate all the harmonic combinations of waves of sound and music.

An addition, wherehy the paper may be slowly rotated by a clock-work movement, while the vibrations are going on, gives extraordinary figures, some of which illustrate the laws of interference and the polarization of light.

To avoid the characteristics due to the decression of motion of the pendulums, Hopkins devised apparatus vibrated by electricity. In one case two reeds or tongues vibrated by an electric current and connected with a single mirror, which latter receives a beam from a lantern and reflects the errant beam through a lens and upon a screen; the play of the curve being the resultant of the two rectangular vibratory movements. See ELECTRICAL DIAPASON, pp. 293, 294, *supra*.

A simple form, using two spring slips with apertures, and vibrating in planes at right angles, is described by Hopkins, * "*Scientific American*," xliii. 259. The length and weight of the slips determine the period of their vibration, the force applied in snapping them the amplitude of the vibrations.

"If the two springs are set in motion by snapping them simultaneously with the thumb and finger, the square aperture formed by the intersection of the slits in the two cards will move so rapidly as to appear like a band of light, *i. e.*, supposing the operator to be looking through the aperture toward the light. If the two springs vibrate in unison the band will either be perfectly straight, bisecting the angle formed by the two springs, or it will be elliptical or circular. By changing the period of the vibration of one of the springs so that the periods of the two springs will be to each other as 1 : 2, the band of light will assume the form of the figure 8. Make the vibrations as 2 : 3, and the figure representing the fifth will be formed, and so on throughout the whole range of compound vibrations.

"To project these figures on a screen all that is required is to place a lamp at one side of the slitted cards, and a mag-

nifying glass of about 6′′ focus on the other side. An easy way to hold the maguifying glass in position is to place the handle in a hole in a board, the latter resting on the top of the box. This rude device admits of moving the lens forward or backward, and to the right or left, as may be required "— *Hopkins.*

The subject may be pursued by reference to the following captions, and citatious *passim:* —

See CURVE INSTRUMENT, p. 236; ELECTRICAL DIAPASON, p. 293; FLAME MANOMETER, Fig. 1046, p. 344; HARMONOGRAPH, p. 439; INTERFERENCE APPARATUS, Fig. 1159, p. 502, *supra;* aud PENDULUM INSTRUMENT, *infra.*

List'ing Plow. A double-moldboard plow, used in listing; that is, throwing up the soil into ridges. A plan adopted in some cultures, such as beet, and some garden crops.

Lith'o-gram. A name given to the gelatine copying process. See COPYGRAPH, p. 220, *supra;* GELATINE COPYING PROCESS, pp. 396, 397, *Ibid.,* and references *passim.*

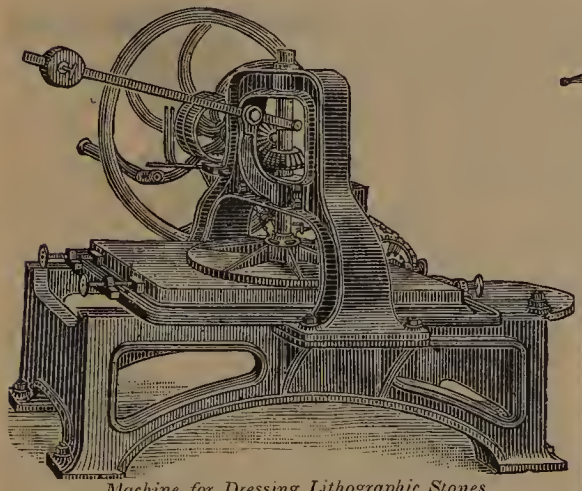
Lith'o-graph'ic Pa'per.

For Transfer Purposes: Chinese paper is much used, and is worked just as it comes from China, being rough in appearance, full of straws and imperfections. These imperfections are removed by the transferer while the paper is damp, as much as possible.

India Proof Paper: Chinese paper, smooth in appearance, different in shades of color or tints. These tints are selected by the lithographer according to the different subjects he may have to prove; for instance, a portrait of a lady of light complexion on light colored India paper; and the reverse when needed. It goes from China to France, and is there calendered and worked over, that the best printed results may be obtained therefrom, and is consequently much more expensive, costing at least three times as much as the Chinese transfer paper.

Lith'o-graph'ic Stone Dres'ser. A machine

Fig. 1613.



Machine for Dressing Lithographic Stones.

for facing lithographic stones. In *Jullien's* machine (Fr.), Fig. 1613, the stone lies upon the flat platen, face upward, and the circular wheel rotates above, while the stone is traversed backward and forward by means of a pitman connected to the platen and moved by wrist connection with a wheel beneath. The stroke of the platen is regulated by the adjustment of the wrist in a slot, towards or from the center of rotation, and the pressure of the wheel on the stone is regulated by means of a counterbalance weight on an arm which is seen projecting to the left.

In another form of machine, shown at the Vienna Exposition, for polishing off the faces of stone, preparing it for the engraver, the stone is laid upon a solid table, which is stationary, having a large iron platen suspended over it, and held by an arm extending back some 10′, and attached to a wheel lying horizontally and supported by a shaft 2′ long extending from below, where it is connected by cog-wheels to another shaft driven by pulleys and belting from the main shaft. This arm runs between two round blocks or loose pulleys placed in the center on either side of the arm, so that when set in motion this platen of iron moves backward and forward over the stone, while the blocks or pulleys in the center give it a side motion, at the same rate with that of the revolution of the wheel in the rear, thus making the iron platen travel more slowly over the surface of the stone, and giving it the same motion as when operated by hand. It covers the entire surface of a large stone with a uniform polishing. The stone is supplied with water from pipes properly attached, and an occasional supply of sand is furnished by the attendant.

Supply of lithographic stones "*Scientific Amer. Sup.,*" 1292.

Lith'o-la-pax'y Ap'pa-ra'tus. (*Surgical.*) *Bigelow's* apparatus for rapid lithotrity with evacuation. It consists of a lithotritor and syringe, the former and the tube of the latter being introduced alternately through the urethra.

The lithotritor is shown at *a*, Fig. 2978, p. 1336, "*Mech. Dict.*" *Lithotritor* and *lithontriptor* seem to be synonymous terms. *Litholabe, lithoprione, lithoclast, lithorineur,* are terms belonging to special instruments of the same class, and approximately the same duty.

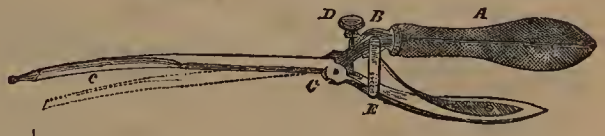
Lith'o-pone. Sulphide of zinc; used as a paint. P. Krupp's Patent.

Lith'o-tome. A bistoury or scalpel for making the incision in lithotomy. The instrument may have a special name derived from structure or mode of application: *gorget, bisector, bistoury-caché, cystotome.*

Hutchison's double-bladed lithotome is shown in Fig. 1614. The handle *A* holds a bistoury, *B*, curved on the flat, its cutting edge looking towards the right, the back being thick and terminating in a rounded probe-point to fit the groove of a lithotomy staff.

A second bistoury, *C*, is joined to the other by means of a screw, its beveled point resting against a section of the probe of the first one, and its cutting edge looking towards the

Fig. 1614.



Hutchison's Lithotome.

left. By this arrangement the blunt back of one blade conceals and protects the edge of the other, so that when the screw *D* is brought home the two blades become solid like a rounded staff. By approximating the wooden handle of the first and the steel lever of the second bistouries, the cutting edges are diverged, the extent of the incision being regulated by the screw *D* and measured by the index-plate *E*.

Li-thot'ri-ty and Li-thot'o-my In'struments. (*Surgical.*) The list includes: —

Anklets and wristlets to secure the patient.
Forceps to grasp and crush the stone.
Lithoclast *b*, Fig. 2978, p. 1336, "*Mech. Dict.*"
Lithotrite *a*, *Ibid.*

The following are from Part III., *Tiemann's* "*Armamentarium Chirurgicum*": —

Fenestrated forceps	Fig. 137.
Lithoclast	Fig. 158, 158 *b*, 173.
Maisonneuve's stone-crusher	Fig. 138.
Curved forceps	Fig. 140.
Straight forceps	Fig. 136, 156 *b*.
Goulay's lithoclast	Fig. 158.
Lithotomy staff	Figs. 131-135.
Blunt gorget	Fig. 189.
Gorget and staff	Figs. 149, 149 *f*.
Scalpels and bistouries	Page 40.
Lithotomes	Pages 40, 41.
Lithotomy scoop	Fig. 149 *e*.
Tenacula	Fig. 154.
Aponeurotome	Fig. 155.
Artery compressor	Fig. 156.
Hooked gorget	Fig. 152.
Dilators	Figs. 157, 157 *b*.
Hydro-hemostat	Fig. 157 *c*.
Evacuating apparatus	Figs. 159-164.
Catheters	Figs. 165-168.
Urethral forceps	Figs. 169-171.
Urethral scoop	Fig. 172.
Lithotome	Fig. 34, Sup.

Lit'mus Paper. Unsized paper colored with

litmus (*Cryophora tinctoria*), and used as a test of the presence of acid or alkalies. It turns red with acids, blue with alkalies.

Lit'ter Cut'ter. A machine of the nature of a chaff-cutter, for cutting straw into lengths for bedding for animals.

Lit'tle Gi'ant. (*Mining.*) A jointed iron nozzle used in placer mining. See HYDRAULICKING, *supra.*

Live Ring. (*Bridge.*) A circular gang of wheels, as used in the turn-tables of draw-bridges, and in those for locomotives.

The *live-ring* of the Rock Island draw-bridge is composed of 34 wheels, each 30″ in diameter and 14″ face. The traveling weight borne by each of the wheels is 44,250 pounds.

Live Trap. (*Optics.*) A contrivance for keeping a live object in the field of a microscope without preventing its movement. This is done by making a hole in a piece of glass of the size of the field of view of the microscope and covering the same with two slips of thin glass. The parts of the apparatus can all be taken apart for purpose of cleaning.

It is accompanied with a glass trough into which one end of the live trap can be placed so as to supply the small aperture with fresh water by capillary attraction when the object under examination is in water. The apparatus enables the object to be kept alive many days.

Fig. 1615.

Live Trap.

Liz'ard. (*Nautical.*) Otherwise known as a buntline bull's-eye. A large thimble worked into the foot-rope of a sail.

Fig. 1616.

Lizards.

a. Lizard.
b. Iron-strapped lizard for awning-blocks.

Lla'nos. (*Fabric.*) A French dress goods woven on a taffeta loom; it has a cotton warp and a weft of mohair, or mohair mixed with silk.

The warp is composed of 3 white threads; the weft is violet, blue, or black, which gives reflection to the stuff.

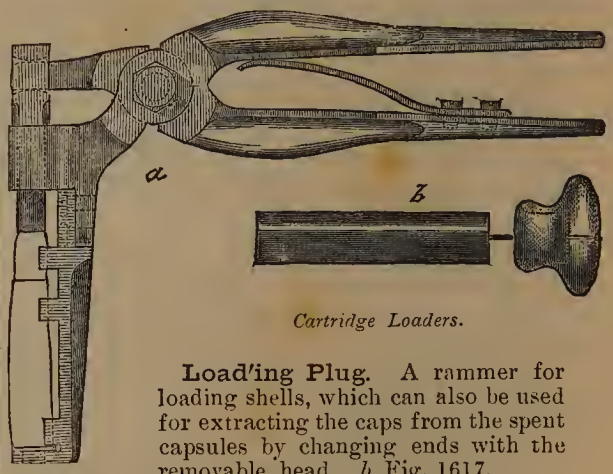
Load'er. An instrument for re-loading cartridge shells. (Fig. 1617.)

The instrument *a* has a prop for the shell and a plunger for the loading, the pressure being given by approaching the handles in manner of a forceps.

b is a powder or shot rammer, and at one end has a point which may be employed to dislodge the spent percussion shell.

a and *b* are manifestly not intended for the same shell. *a* is shown compressing the bullet into a bottle-shaped shell.

Fig. 1617.



Cartridge Loaders.

Load'ing Plug. A rammer for loading shells, which can also be used for extracting the caps from the spent capsules by changing ends with the removable head. *b* Fig. 1617.

Load'ing Ma-chine'. (*Cartridge.*) A machine for loading the shells of cartridges. The shells are fed in on a revolving wheel; 72 grains of powder are let in from above by a funnel from the can, and on revolving farther the bullet is pressed into the neck of the shell.

Loam and Sand Core. A dry-sand core, composed of sharp sand, loam, and horse manure. In these cores the loam is used in place of flour or other substances for giving strength and adhesiveness to the sharp sand.

Lob'ster Claw. A screw jack used in setting rigging. See RIGGER SCREW.

Fig. 1618.

Lobster Claw.

Lo'cal Ac'tion. (*Electricity.*) This takes place when the zincs require amalgamation. A hissing sound in the cells when the poles are not connected indicates a waste of battery material. It is remedied by re-amalgamating the zincs.

Lock. See for history and varieties, pp. 1338, 1342, "*Mech. Dict.*" A list is given on the last-mentioned page.

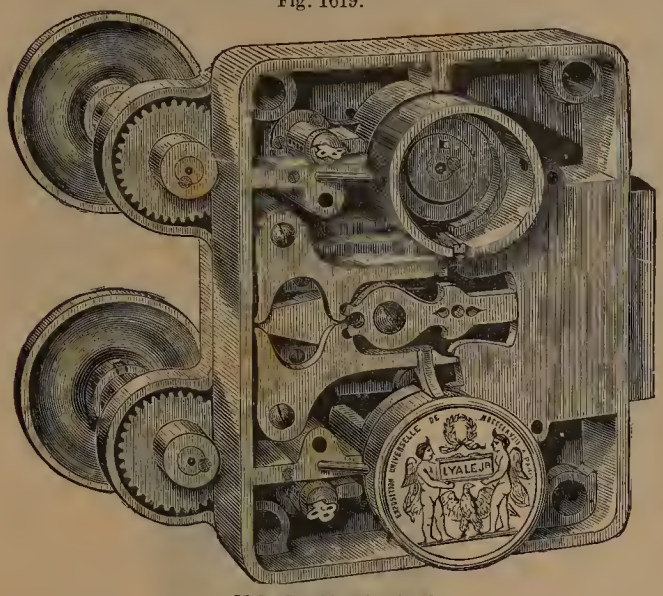
The Yale double-dial lock, Fig. 1619, is a double combination bank or safe lock having two dials, each operating its own set of tumblers and bolts, so that two persons, each in possession of his own combination, must be present in order to unlock it. It is evident that the two dials may be set on the same combination, or one person may possess the two combinations, if the double security be not desired, temporarily.

The *Time Lock* has a chronometer movement inside by which the bolt is permitted to unlock at predetermined times. Set to lock at 4 P. M., and to open at 9 A. M., for instance, the door being closed at the stated time (4), the unlocking mechanism cannot be operated until the 17 hours have elapsed. By a Sunday attachment, the recurrent 7th days an additional 24 hours is added to the 17 (= 41 hours), during which the lock cannot be operated, nor the door opened.

Fig. 1620 shows the appearance of the lock, and enables its principles to be sufficiently explained.

The only parts of the lock which are not visible are the two chronometer movements which are concealed by the plate, and which cause the two dials to move in the directions indicated by the arrows. These dials are constructed with 24 pins representing the 24 hours, and colored white and black, to indicate the day hours and night hours. When these pins are pushed in they form a track on which the rollers of the yoke ride. The movement of the yoke up and down moves the lever, to which the yoke is pivoted, up and down also. It is necessary that both sides of the yoke should be pushed up by the revolution of the dials, in order

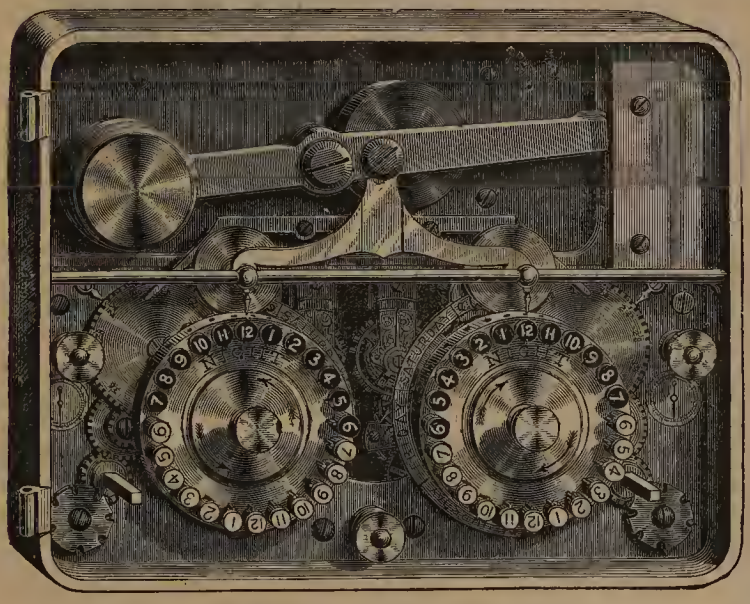
Fig. 1619.



Yale Double-dial Lock.

to push up the lever. When the pins of the dials are pulled out, the track on which the rollers of the yoke ride is broken away, and the yoke and lever are allowed to drop by gravity. At the left-hand end of the lever, as you look towards the cut, is shown a counterbalance weight, while the other end of the lever works in a slot in a movable dog or bolt. The sole object of the time lock is to cause this bolt to move up

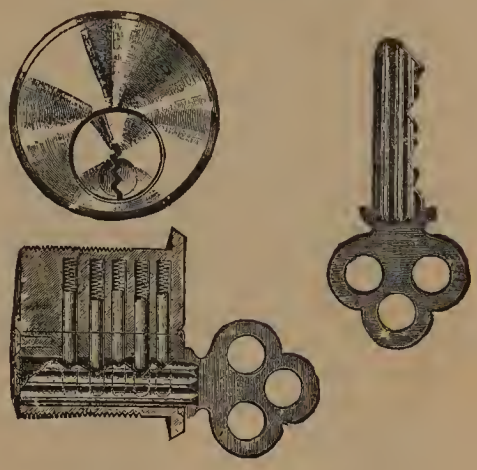
Fig. 1620.



Yale Time Lock with Sunday Attachment. (Cover Removed.)

and down at certain regular intervals. When the bolt is moved up it closes a hole in the case into which a projection on the string piece of the bolt work passes, when the bolt work is retracted. When the bolt drops the projection can pass freely into the hole and the bolt work be retracted. The construction of the bolt is such that pressure upon it causes no pressure whatever on the lever, but the pressure is resisted by a solid block backed up by the case of the lock. The operation of the lock is therefore as follows: The user selects the hour at which he wishes the lock to lock up, and pushes in that pin, and pushes in all the succeeding pins up to the hour when he wishes the lock to unlock, doing this on both dials, and setting the dials to the proper hour of the day by the pointer at the top of each. Now, so long as the movements are running, the pins, which are pushed in, will support the yoke, lever, and bolt, and keep the lock locked, while it will remain unlocked during all the hours represented by the pins which are pulled out. These periods can be varied at will. If the safe door is left open longer than usual, so that the projection from the bolt work is in the hole of the lock case when the hour comes at which the lock is set to lock, the rollers of the yoke will be raised, but the only effect will be to separate

Fig. 1621.



Yale Lock.

the yoke at the center, and to cause a spring which holds it together at that point to spread. When the bolt work is thrown forward, and the lever and bolt are free to rise, the spring will contract and push them up in the locked position. The lock is provided with what is called a Sunday attachment, that is, with a segment or track which comes under the rollers every seventh day and keeps the lock in a locked position over Sunday, during the hours when it will unlock on other days. This can be adjusted so as to lock up over a holiday also. To prevent the lock running down in the locked position so as to cause a lock-out, a supplemental unlocking device is provided, and consists of a coiled spring situated back of the lever. This is held coiled by two triggers which extend over the wheels, which indicate the number of hours that the movements are wound up to run. As the movements run down these wheels revolve with them, and just before either movement completely runs down a pin trips the trigger, and releases the spring which pushes down the lever and bolt, spreading the yoke apart.

Yale's pin lock, which is operated by a flat key, was a new departure, seen in position in the lock in the sectional view, Fig. 1621.

In the *Yale* lock the *escutcheon* or *tumbler case*, inclosing the pins upon which the bits of the key operate, is placed near the surface of the door, projecting slightly, so that a long key shank is dispensed with, the bow and bits brought closely together, and the depth of the escutcheon decides the length of the key, without regard to the thickness of the door.

The escutcheon cylinder is an exterior shell, containing in its lower part a smaller cylinder, from which rises a rib of metal containing the *pin chambers*, and within which is the *plug*, attached to the inner end of which is the cam that imparts motion to the bolt. This plug also contains the key hole.

The escutcheon contains five holes, or *pin chambers*, each formed partly in the shell and partly in the plug, therefore a pin which filled one of these holes would prevent the rotation of the plug, but, if the pin were cut in two, the joint corresponding with that between the plug and its hole, the plug could revolve freely, carrying with it one half of the pin, and leaving the other half in that part of the pin-chamber contained in the shell. Such is precisely the construction of the lock and its great element of security. The line of junction may be seen in the upper view, Fig. 1621.

Each pin is in two parts, — the upper termed the *driver*, the lower the *pin*, — and above each driver is a light spring, tending to press drivers and pins downwards. In this position the drivers intersect the joint between the shell and the plug, completely preventing the rotation of the latter. To open the lock, therefore, all the pins must be raised simultaneously to just the proper height, which can be done only by the right key, since a variation of one-fiftieth of an inch

in the elevation of either of the pins will prevent the opening of the lock.

The width of the key admits of ten different *bittings*, or depth of notches, therefore a lock with but one pin could be variously *set up*, so as to be opened by ten different keys. In a lock with two pins the number of changes, or varieties of keys, will be 100; three pins, 1,000; four pins, 10,000; five pins, 100,000; six pins, 1,000,000; seven pins, 10,000,000. The least number of pins contained in any of the Yale locks is 4, as in drawer and desk locks; the night-latches have 5; the post-office, heavy store-door locks, etc., 6; and the "safe-deposit" locks — for inside doors of safes, vaults, etc. — have 7 pins.

The new Yale corrugated key consists of the original plate key altered by having its blade, or portion which enters the lock, corrugated in longitudinal lines. By special machines of great ingenuity, the lock has formed in it a key-hole of sinuous cross section conforming to that of the key. The key and its hole are interlocked throughout their entire length, and tilting of the key in its hole is impossible. The lock cannot be operated by any key but its own, nor can it be picked except by some tool which will raise the tumblers. The shape of the key-hole renders it impossible for any tool to raise the tumblers, because, even if one be made small enough to be inserted in the key-hole, it cannot be moved up and down.

See under the following heads: —

Carriage spring-lock.	Nut lock.
Coach lock.	Padlock.
Combination lock.	Sash lock.
Dead lock.	Scandinavian lock.
Drawer lock.	Safe lock.
Gate latch.	Seal lock.
Jail lock.	Seat lock.
Janus-faced lock.	Time lock.
Keyless lock.	Window latch.
Letter lock.	Wagon lock.
Night latch.	Yale lock.

Lock Bed'der. A machine for sinking a recess in a gun-stock for the lock.

The general appearance of this machine is similar to a revolving head gang drilling-machine containing five spindles with their cutters. The rifle stock is chucked in a fixed position; to the right of it, and also fixed, is an iron section of that part of the stock into which the lock is bedded; the iron section is used as a guide or former. The machine being started, the first operation is to drill two holes, the position of which is regulated by a pin which reaches the iron former a little in advance of the drill reaching the rifle stock, so that the position can be accurately determined. One hole being drilled, the spindles carrying the drill and the guide pin, which spindles are in the same frame and operate together, are raised, the machine head is swung one fifth of a revolution, and the first cutter comes in position to operate. On lowering the cutter spindle there descends with it, and slightly in advance of it, a guide pin in the iron former, and when the guide pin is well within the iron former the cutter reaches the surface of the wood, and is guided by the operator moving the head so that the guide pin travels all around the edge of the recess in the former. The motion of the guide pin and of the cutter being laterally identical, the operator has but to enter the cutter as far into the rifle stock as a stop provided for the purpose will admit, and then to move the frame carrying the guide pin and cutter so that the guide pin moves and touches all around the sides of the recess in the iron former. The recess in the rifle-stock will be then the exact counterpart, in size, form, and depth, of that in the pattern. The whole operation is but a repetition of the above, with the remaining cutters swung one after the other into position, the one iron former answering to regulate the lateral movement of them all. The speed at which the cutters revolve is about 8,000 revolutions per minute. As soon, however, as each drill or cutter is swung out of position, it stops running, which prevents wear and tear.

Lock Chain. A short chain by which a padlock is fastened to a door or car so as to be irremovable.

Lock Fau'cet. One the spigot of which can only be turned by a removable key.

Lock Gate. The gate of a bay in a canal lock.

Designs for hanging lock gates, and valve for locks. See Plates III. (*a*), III. (*b*), IV., "*Report of Chief of Engineers, U. S. Army*," 1876, vol. ii., Part II., p. 416 *et seq.*

A report "*On the Construction of Iron Lock Gates for the Harbors of the Weser River, Germany*" (translation), reproduced by the Corps of Engineers, U. S. Army, forms a quarto brochure, Washington, 1873.

Lock Hook. (*Fishing.*) A supplementary hook to spring upon and secure a fish which draws on the bait.

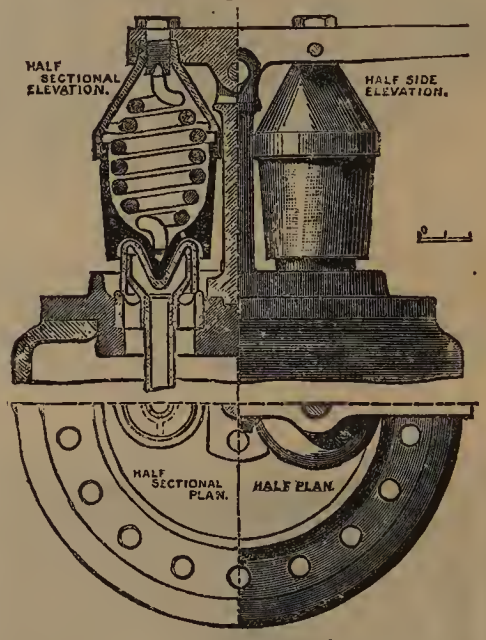
See "*Report of U. S. Fish Commissioners*," p. 275, Part I., 1873, and Fig. 2000, "*Mech. Dict.*" See also Fish Hook, p. 341, *supra*.

Lock'ing Plate. A nut-lock; see 45 illustrations, Fig. 3350, p. 1538, "*Mech. Dict.*"

In Finney's (Br.), a small pin is fixed a short distance beyond the nut. A circular plate, divided equally by 17 notches, fits easily over the nut in any of its six positions. The principle of the invention is the same as that of the vernier scale. As there are 17 notches in the plate it follows that three of them represent just one-seventeenth of one side of the hexagon nut; so that if the plate be moved round three notches, it will not fit unless the latter be moved round a distance equaling one-seventeenth of one side of the hexagon, or a distance which equals the one hundred and second part of a whole turn.

"*Iron Age*," xxii., August 1, p. 19.

Fig. 1622.



Lock-up Safety Valve.

Lock'-jaw In'stru-ment. (*Surgical.*) Apparatus for forcing open the jaws.

Goodwillie's operates by a screw which acts upon two hinged valves, introduced, wedge-fashion, between the teeth.

Westmoreland's has two parallel plates expanded by a screw.

Some of the heavier forms of *speculi oris* may be similarly used.

Lock Mor'tis-ing Ma-chine'. A machine for boring holes in the edges of doors to hold mortise locks.

The machine is clamped to the door, spanning the edge at the height desired to set the lock; a bit of the width of the lock body is placed in the bit-holder, which works in guides to secure verticality, and is rotated by hand-crank and gearing. An adjustable stop on the bit-stock determines the depth.

Lock Nut. See Fig. 3350, p. 1538, for numerous varieties.

Locking plate.

Finney, Br.	* "*Engineer*," xlv. 464.
Lock nut, *Ibbotson*, Br.	* "*Engineer*," xlvii. 352.
Stouffer	* "*Iron Age*," xxi., Feb. 28, p. 1.
Wile, Br.	* "*Engineer*," xliii. 276.
	* "*Engineer*," xlvii. 78.

Lock Seal. A piece of glass, lead, or paper over the key-hole of a padlock, so that the latter cannot be tampered with without defacing the seal. Used on cars containing goods *in transitu*, in bond, etc.

Lock Switch. A form of switch board used in telegraphy.

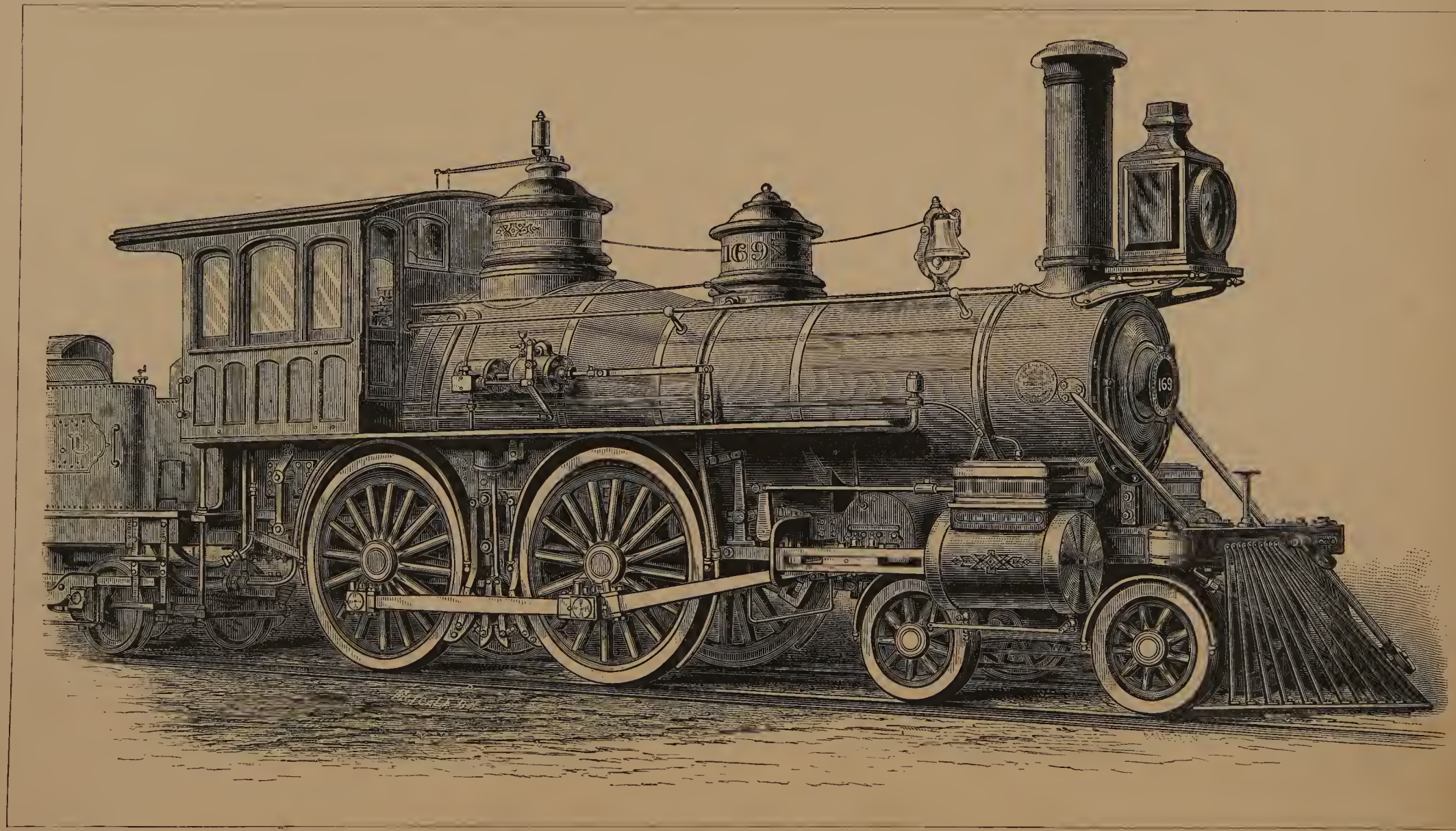


PLATE XXVI. AMERICAN TYPICAL LOCOMOTIVE; CENTRAL RAILROAD, NEW JERSEY. *See page 555.*

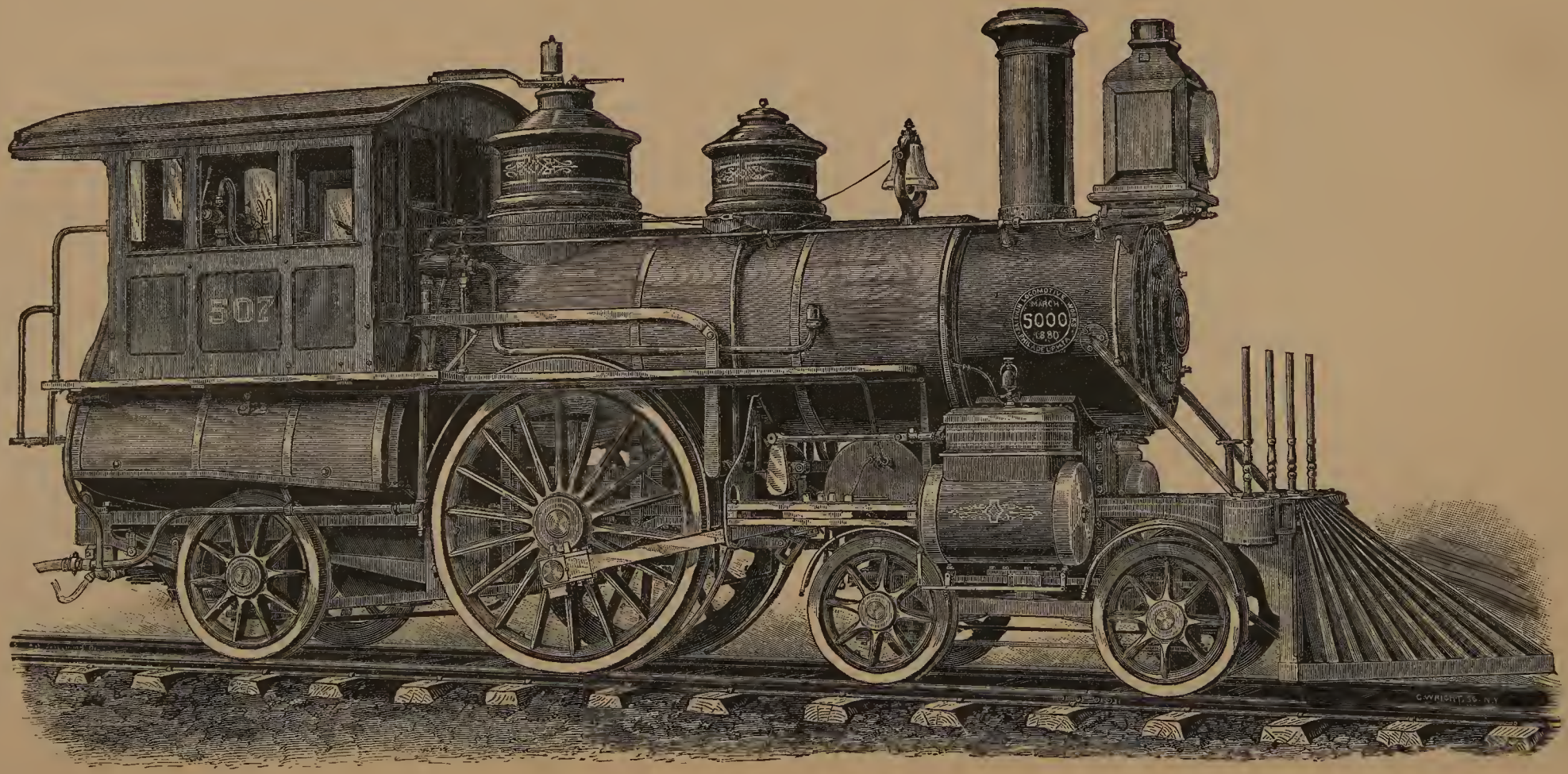
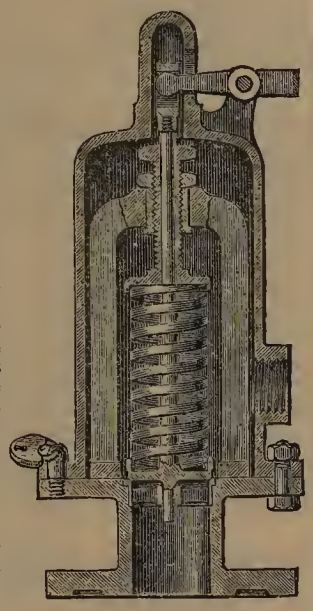


PLATE XXVII. FAST PASSENGER LOCOMOTIVE: BOUND BROOK LINE, NEW YORK AND PHILADELPHIA *See page* 555

Two sets of brass bars are arranged at right angles to each other on opposite sides of a wooden frame. The connection is made between any two intersecting bars by a metallic peg, provided with a spiral spring, which, when the peg is inserted and secured in its place, presses against the two bars, forming an electric connection. See PIN SWITCH.

Lock'-up Safe'ty Valve. One in which the weight or spring is in a closed chamber which cannot be tampered with, or changed, except by one having possession of the key.

Fig. 1623.



Lock-up Safety Valve.

Fig. 1622 is *Wilson's* improvement on *Klotz's* safety valve. The springs are not accessible, although the engineer can ascertain by lifting the trying lever, whether the valves are in good order. Valve and seat are of gun-metal, having the same ratio of expansion.

Fig. 1623 is *Stone's* locked-up safety valve (Br.), in which the lever operates in a yoke on the valve-stem, being efficient in lifting, to prove the condition of the valve, but powerless to add pressure thereto.

See also Fig. 2983, p. 1343, "*Mech Dict.*," and Fig. 4544, p. 2019, *Ibid.*

Lo'co-mo'tive. See "*Mech. Dict.*," pp. 1343–1348.

Plate XXVI. gives a view of a first-class, fast engine of the ordinary American type, with four connected driving wheels and a four-wheeled truck. It was built by the Baldwin Locomotive Works, for the Central Railroad of New Jersey, for fast passenger service. The special points of improvement in construction and proportion are carefully and elaborately detailed, accompanied by sectional views, in the "*American Machinist*," * v., pp. 1–3, January 7, 1882, to the publishers of which journal the author acknowledges his indebtedness for the plate.

"The train usually consists of five cars, viz., one baggage, one express, one Pullman drawing-room coach, and two ordinary passenger coaches. With this train, notwithstanding the fact that the smoke-stack is well inclosed within the smoke-box, to prevent throwing fire, plenty of steam is generated at all parts of the road. The regular schedule time between Jersey City and Bound Brook is 37 minutes. This distance has been run by No. 169 in 33 minutes. Three miles upon the route have been run in 2 minutes and 24½ seconds, — the same distance frequently covered in 2½ minutes. The quickest mile ever run by this locomotive was in 45 seconds, — timed between mile posts with a stop-watch." — "*American Machinist.*"

The following are some of the principal dimensions: —

Gage of road	4′ 8½″
Weight (running)	93,000 lbs.
Cylinder diameter	18″
Stroke	24″
Driving wheel, diameter	68″
Wheels, diameter	32″
Boiler, thickness, steel	⅜″
Diameter	52″
Fire-box, length	125⅞″
Width	43¾″
Tubes, number	200
Diameter	2″
Length	11′ 5½″
Grate, area, sq.	38′
Heating surface, box, sq.	145′
Tubes, sq.	1175′
Total, sq.	1320′
Steam power, normal	140 lbs.

A freight locomotive by Rogers, having four pairs of coupled drivers, is shown in Fig. 1624.

The original "Consolidation" locomotive was built in 1866 from the plans of Wm. Alex. Mitchell, at the Baldwin Works in Philadelphia. This type of locomotive has four pairs of drivers and a two-wheeled pony truck in front. It was originally built to overcome some steep grades on the Lehigh Valley Railway, and specially for the Mahoning Plain, which rises 133′ to the mile.

Plate XXVII., for which the author acknowledges indebtedness to the "*Railroad Gazette*," gives a view of locomotive 5000, built at the Baldwin Locomotive Works, Philadelphia, for the fast train between New York and Philadelphia on the Bound-Brook route. A careful description with sections and elevations is in the journal mentioned, * vol. xxiv., 246, 315.

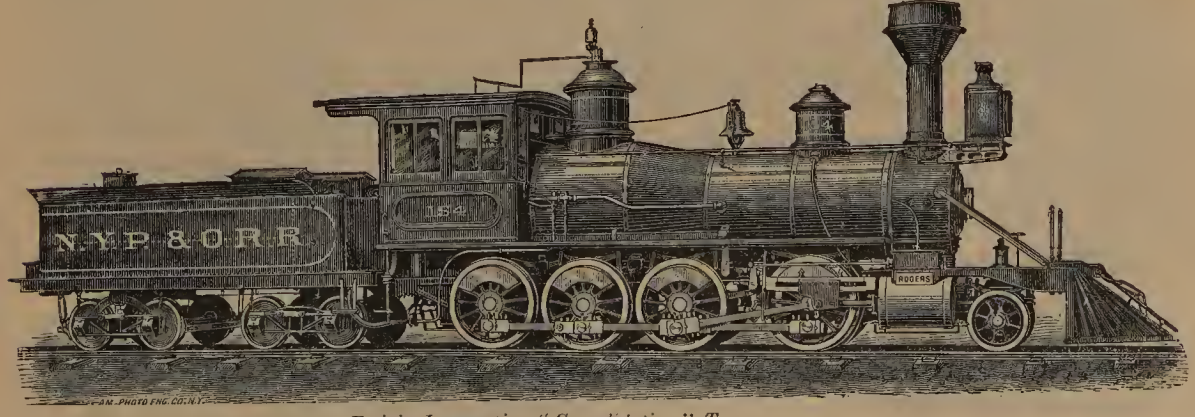
"This new locomotive has a single pair of driving wheels 6½′ in diameter, in place of coupled drivers of 5½′ in diameter. In the latter form of engines run at high speed there is danger that the coupling rods connecting the driving wheels will be broken by centrifugal force. The larger wheel also reduces the number of revolutions per mile of run. In the new locomotive the boiler has 1400′ square of heating surface and about 56′ square of grate surface. The dimensions are as follows: —

Diameter of cylinder, 18″.
Length of stroke, 24″
Diameter of driving wheel, 78″.
Wheel base, 21′ 1″.
Distance from center of driving wheel to center of trailing wheel, 8′
Boiler, 7-16″ steel . . . 52″ in diameter.
No. of tubes, 198 . . . 2″ in diameter and 12′ 2¾″ long.
Fire-box . . . . . 96½″ by 84″.
Capacity of the tender . . . . . 3,800 gallons.
When filled with water and coal, 70,000 pounds.

"The weight of the engine is 85,000 lbs., and is so disposed that by an alteration of fulcrum points additional weight can be thrown on the drivers at the time of starting.

"At a trial trip on May 14th, the engine was attached to a train of four cars, each weighing about 42,000 pounds, making the weight of the train complete, about 148 tons. The run was made at rates ranging from 27 miles an hour, between Ninth and Green and Wayne stations, to 62 miles an

Fig. 1624.



Freight Locomotive, "Consolidation" Type.

hour, between Trenton Junction and Bound Brook, the time from Ninth and Green to Jersey City (89.4 miles) being 98 minutes, or at the rate of 54¾ miles per hour. On the return trip the run was made in 100 minutes. In a former trip the engine developed a speed of nearly 79 miles an hour. In these trial trips the engine consumed 36 gallons or 300 pounds of water per minute." — *Le Van.*

Dimensions of Mogul Passenger Locomotive, No. 600, Built by Baltimore and Ohio R. R. Co.

Gage of road	4′ 8½″
Driving wheels, number	6
Diameter	60″
Truck wheel, number	2
Diameter	31″
Total wheel base	22′ 11″
Cylinders, diameter	19″
Stroke	26″
Steam ports	1¼″ × 15½″
Exhaust	2¾″ × 15½″
Throw of eccentrics	5½″
Boiler, diameter	50″
Fire-box, length inside	99 7–16″
Length outside	9′
Width on top	45⅞″
Width on bottom	34⅝″
Depth in front	4′ 8″
Depth in back	3′ 4″
Grate surface	23.7′ sq.
Heating surface in fire-box	122′ sq.
Flues	1150′ sq.
Total	1272′ sq.
Flues, length	11′ 10″
Number	165
Diameter	2¼″
Weight on truck wheels	13,850 lbs.
Driving wheels	76,550 lbs.
Total weight, running	90,400 lbs.

Locomotives for steep gradients are of several kinds, among which may be noticed the following: —

1. The Fell system, so called, in which a pair of horizontally rotating wheels or rollers embrace a central rail. This was used by him on Mt. Cenis and Mt. Washington. See also Vignoles and Ericsson's central rail (Fig. 1210, "*Mech. Dict.*"). This was patented by these parties in England in 1830, which is doubtless much older than Fell's invention. Kollman's English patent of 1836; Sellers' United States patent of 1835.

2. The Righi railway (Fig. 4124, "*Mech. Dict.*"), which has central rack engaged by spur wheel on the locomotive. This was patented in England by Blenkinsop in 1811, Snowden in 1824, Easton in 1825.

3. Coleman's (English patent 1845), in which a screw beneath the locomotive works into a line of rollers laid down midway between the rails.

4. James' (English patent, 1825), converting each wheel of the train into a driver. A horizontal shaft extending beneath the carriages from the locomotive throughout the train, rotated by the locomotive and having bevel wheel connection with the axle of each car. See p. 1861, "*Mech. Dict.*"

5. Handyside's system, in which the locomotive, provided with a winding drum and wire rope, proceeds up the incline in advance of the train, and, after being anchored to the rails, draws up the train after it by the wire rope.

6. Appleby's system, in which a chain is laid between the rails and passed over by a chain wheel of the same diameter at the pitch-line as the wheels of the locomotive. The engine hauls by adhesion on the level and lays hold of the chain when going up or down steep grades.

For most of these engines vertical boilers have been used on account of the small foundation space they occupy, and because there is less uncovering of the flues when the boiler is on a heavy grade.

The locomotive attachment of *Wootten & Hazel* is designed to enable a locomotive on one track to impel an engine or car on another. A ram is pivoted to the locomotive and may be folded against the same or extended by an adjustable spring-brace rod, to a position to engage the car on a side track to move it forward.

The fast trip from New York to San Francisco was made in 83 hours, 34 minutes.

The "Uncle Dick" locomotive for the Atchison, Topeka and Santa Fé railway weighs 65 tons, and is 60′ long from the head-light to the rear of the tender.

Boiler, length	21′
Cylinder, diameter	20″
Stroke	26″
Drivers (8), diameter	42″
Restraining force of brakes	75 tons.

The largest locomotive at Vienna weighed 70 tons, and could draw 1000 tons at 30 miles per hour.

See also under various heads: —

Back-truck.
Coal-dust burning.
Compound.
Compressed air.
Consolidation.
Farm.
Fire engine.
Fireless.
Geared.
Ice.
Logging.
Mahovo.
Mining.
Mogul.
Narrow gage.
Plantation.
Pony-truck.
Portable engine.
Steam plowing.
Switching.
Tank.
Traction engine.
Tramway.
Waste burning.

See the following references: —

Air locomotive . . . page 16, *supra.*
Anthracite dust, *Wootten* * "*R. R. Gazette*," xxiii. 155.
* "*Engineer*," xxvii. 67.
* "*Scientific American Sup.*," 4012.
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Nord-Bahn . . . . * "*Engineering*," xxvi. 274.
Austrian State Ry. . . * "*R. R. Gaz.*," xxii. 537, 549–559.
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* "*Scientific American Sup.*," 583.
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(21 Figs.) . . . . . * "*Engineer*," xlviii. 85.
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"*Scientific Amer.*," xxxvii. 260.
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See COMPRESSED AIR ENGINES, p. 215, *supra.*
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Lo'co-mo'tive Bal'ance. The spring on the safety valve beam of a locomotive. Preferred to a weight on account of steadiness and lightness.

Fig. 1625.

Locomotive Balance.

Lo'co-mo'tive Crane. A crane mounted on a car. A wrecking or construction crane. See RAILWAY CRANE, *infra*. Also, BALANCE CRANE, Fig. 176, p. 66, *supra*, and *j*, Fig. 1507, p. 643, "*Mech. Dict.*"

Lo'co-mo'tive Cup. An oiler for the cylinder of a locomotive.

Fig. 1626 shows the *Nathan & Dreyfus* oiler, which is self-acting.

While the engine is in motion, the steam passes up the tube to the upper part of the cup, where it condenses, and the water so produced, being heavier than the oil, sinks to the bottom and lifts an equal amount of the lubricant to the top, causing it to overflow through the side hole near the top of the tube to the parts where the lubrication is required.

At the end of the day, or when the oil or tallow is exhausted, water, acids, and other impurities which remain should be drawn off by the waste-cock, and the cup refilled with the lubricant.

Lo'co-mo'tive Pump. A self-propelling steam-power pump. The most familiar is a steam-driven fire-engine; a self-moving engine carrying a pump: the *locomobile pompe* of the French, with whom it is more common than with us.

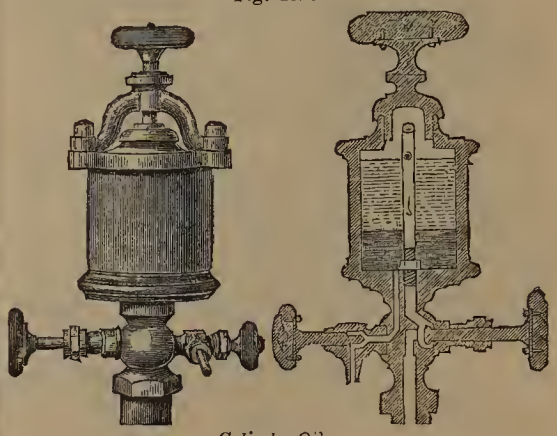
Lode. (*Mining.*) Aggregations of mineral matter containing ores in fissures.

Lodg'ing Car. A car fitted with bunks for hands at work on a railway line.

Log. A velocimeter; employed to ascertain the rate of a ship's motion. See p. 1348, "*Mech. Dict.*"

In Keelmay's electric log an electric circuit is applied to the ordinary patent log, so that a revolution of the vanes

Fig. 1626.

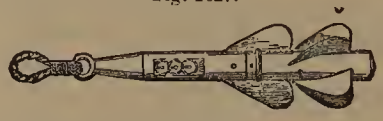


Cylinder Oiler.

will, by a make-and-break arrangement, actuate an indicator in the captain's cabin. The number of knots can be read off the indicator, and hauling in the log itself is not required.

Massey's log has spiral wings, propelled by the passing water, and the revolutions registered by wheel-work and dials inside.

Fig. 1627.



Massey's Log.

A French log is described as an instrument to be fixed either in the engine-room or in the captain's cabin. The water is conveyed to it by means of suitable valves, placed in the side of the vessel, and the impact of the water while the vessel is moving communicates motion to some clockwork, and the distance is recorded by means of a dial. There are four smaller dials within a large one which record the knots by units, tens, hundreds, and thousands, while the large dial tells the statute miles, so that measurement can be taken either in miles or knots.

Froude, Br.	"*Van Nostrand's Mag.*," xviii. 344.
De Normanville, "*Engineer*"	* "*Scientific American Sup.*," 1522.

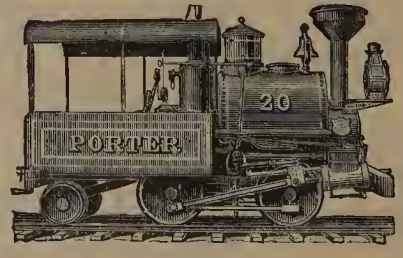
Log Beam. The traveling frame in which a log lies and travels in a saw-mill. Fig. 4629, p. 2043, "*Mech. Dict.*"

Log But'ter. A drag saw for *butting*, *i. e.*, cutting off square the ends of logs.

Log Frame. A name for a saw-mill, *i. e.*, DEAL FRAME, Fig. 1601, p. 680, "*Mech. Dict.*"; also Plate LIV., p. 2042, *Ibid.* Plate III., p. 72, *supra*.

Log'ging Lo'co-mo'tive. A light back-truck locomotive used on logging and plantation roads,

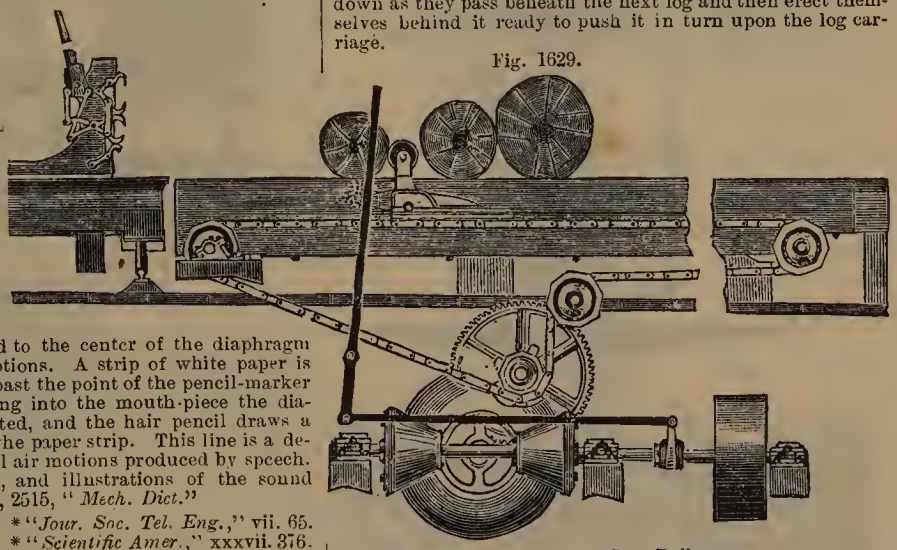
Fig. 1628.



Logging Locomotive.

where the track is usually uneven and the speed slow; also for shifting and switching, and for local passenger traffic on narrow-gage roads.

Log'o-graph. An instrument by Barlow (Br.) for giving a graphic representation of the vibratory motions of the air-waves of speech. It was thought possible it might become a substitute for short-hand writing. It depends for its action on the well-known fact, that, in articulating, the air is forcibly expelled from the mouth in jets of different character by different consonant sounds; this, irrespective of intensity, is due, in part, to the specific energy of expiration in the enunciation of the consonant; some of these, as is well known, commence with an energetic puff, and others in a much less decided manner. The instrument reproduces all these, and other peculiarities graphically.



It consists in a mouth-piece similar to that of a speaking trumpet, which is inclosed at one end by a thin india-rubber diaphragm about 2½″ in diameter. A small camel-hair pencil, moistened with ink and aniline dye, is attached to the center of the diaphragm so as to partake of its motions. A strip of white paper is caused to move uniformly past the point of the pencil-marker by clock-work. On speaking into the mouth-piece the diaphragm is violently agitated, and the hair pencil draws a fine, irregular line along the paper strip. This line is a delineation of the mechanical air motions produced by speech. The subject is considered, and illustrations of the sound tracings given, on pp. 2514, 2515, "*Mech. Dict.*"

Cf. Paper by *Barlow* . * "*Jour. Soc. Tel. Eng.*," vii. 65.
* "*Scientific Amer.*," xxxvii. 376.
"*Scientific Amer. Sup.*," 1923.

Log Rail'way. One the track of which is formed of logs, laid to a gage and parallel. The upper surface is rounded to suit the concave surface of the truck wheels; or, a square scantling is pinned to the log, and the ordinary flanged wheel used with engines and trucks. — "*R. R. Gaz.*," xxiv. 105.

Log Rol'ler. A device in a saw-mill to convey logs from the log-deck or the log-way skids to the head-block.

By the motion of the lever the friction-gear is thrown into action, the chain traverses and the knees come against and push the log upon the carriage, bringing it squarely against the knees of the head-block. Motion of the lever in the other direction throws the other friction cone into connection with the wheel beneath the track, and, the chain being moved in the other direction, the knees retire, being forced down as they pass beneath the next log and then erect themselves behind it ready to push it in turn upon the log carriage.

Fig. 1629.

Emery's Log Roller.

Log Scale. A table which gives the quantity of lumber, one inch thick, board measure, which may be obtained from a round log, the length and the diameter below the bark being given.

TABLE FOR SCALING LOGS.

Length.	Diameter.																				
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	32	34	36
10	40	50	62	75	90	105	122	140	160	180	202	225	250	275	302	330	360	390	422	490	562	640
11	44	55	69	83	99	116	135	154	176	198	223	248	275	302	333	363	396	430	465	539	619	704
12	48	61	75	91	108	126	147	168	192	217	243	270	300	331	363	397	432	469	507	588	675	768
13	52	66	81	98	117	137	159	183	208	235	263	292	325	358	393	430	468	508	549	637	731	832
14	56	71	88	106	126	148	171	197	224	253	283	315	350	386	423	463	504	547	591	686	787	896
15	60	76	94	115	135	158	184	211	240	271	303	338	375	413	453	496	540	586	633	735	844	960
16	64	81	100	121	144	169	196	225	256	289	324	361	400	441	484	530	576	625	676	784	900	1024
17	68	86	106	128	153	179	208	239	272	307	344	383	425	468	514	563	612	664	718	833	956	1088
18	72	91	112	136	162	190	220	253	288	325	364	406	450	496	544	596	648	703	761	882	1012	1152
19	76	96	119	143	171	201	232	267	304	343	384	429	475	523	574	630	684	742	803	931	1069	1216
20	80	101	125	151	180	211	244	281	320	361	404	452	500	551	605	661	720	781	845	980	1125	1280
21	84	106	131	158	189	222	257	295	336	379	425	473	525	579	635	693	756	820	887	1029	1181	1344
22	88	111	137	166	198	232	269	309	352	397	445	496	550	605	665	726	972	859	930	1078	1238	1408
23	92	116	144	174	207	243	281	323	368	415	465	519	575	632	695	760	828	898	972	1127	1295	1472
24	96	122	150	181	216	254	294	337	384	433	486	541	600	661	726	794	864	938	1014	1176	1352	1536
25	100	127	156	189	225	264	308	351	400	451	506	562	625	689	756	827	900	977	1056	1225	1408	1600

Log Turn'er. A device for turning a log on its carriage after slabbing, or to roll it on to the carriage. Fig. 1630.

A spiked bar on the end of a piston rod working in a steam cylinder beneath the log floor, is projected upward so that the teeth or spikes on its surface shall catch against the log and roll it. The steam cylinder can be oscillated on its gudgeons in order to act upon logs otherwise beyond its range, as seen in dotted lines.

B is a flexible steam pipe; *C* is the bar, with teeth *D*. *G* is a supplementary bar which is brought into action to hold the log from rolling back when the toothed bar retires for another hitch. The cylinder is caused to oscillate by putting the foot upon a treadle lever which acts against a transverse arm and tips the cylinder; the latter is restored to vertical position by the counter-weight *J*

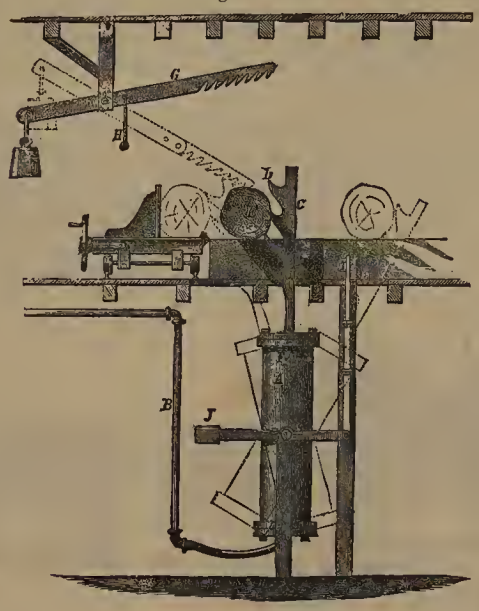
Long Rol'ling Splice. (*Nautical.*) A splice for lead lines, fishing lines, etc., in which the junction is very long and the splice rolled to make it round and symmetrical so as to run freely.

Long Splice. (*Nautical.*) The junction of two rope ends by intertwining the strands for a relatively long distance. See *h*, Fig. 5435; also *a e*, Fig. 5434, p. 2279, "*Mech. Dict.*"

Loom. See for history and instances Figs. 2996–3006, pp. 1351–1358, "*Mech. Dict.*"

Hair Loom, Pawtucket Hair Cloth Co. . . . *Hayes'* "*Centennial Report*," v. 80, 81
Gulcher, "Buckskin" . . . * "*Scientific American Sup.*," 2705.
Picker motion, *Ross* . . *Thurston's* "*Vienna Report*," iii. 290.

Fig. 1630.



Log Turner.

Box, Revolving, French * "*Scientific American Sup.*," 2130.
Positive motion, *Lyall* . * "*Scientific American*," xxxv. 175.
* "*Manufact & Builder*," ix. 88.
Stopper alarm, *Démard* * "*Scientific American Sup.*," 1430.
Harness, *Crowell* . . . "*Scientific American Sup.*," 1648.

See also CARPET LOOM, *supra*; NEEDLE LOOM, *infra*.

Watson's "The Theory and Practice of the Art of Weaving by Hand and by Power."

Loop. (*Fire-arm.*) The projection under the barrel to which the fore end is fastened.

Loop Bolt. (*Vehicle.*) A bolt with ornamented head for securing the body-loop to the running gear of a carriage.

Loop Head. (*Vehicle.*) The swell and eye on the end of a body loop. See Fig. 358, p. 114, *supra*.

Loop Knot. (*Nautical.*) A form of hitch. See 27, Fig. 2777, p. 1240, "*Mech. Dict.*"

Loop Yoke. (*Vehicle.*) A loop for the strap by which the swaying of the body is limited. See *d*, Fig. 358, p. 114, *supra*.

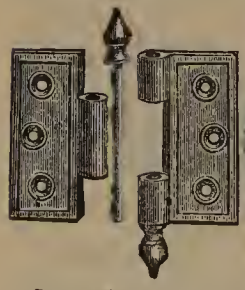
Loose Box. (*Manége.*) A partitioned space in a stable where a horse may be confined without haltering.

Loose Hook Block. (*Nautical.*) A block the hook of which is secured by a loop to the eyes of the block-strap, instead of being rigid therewith.

Loose'-joint Hinge. One in which the leaves are detached by lifting the blind, door, casement-window, or what not.

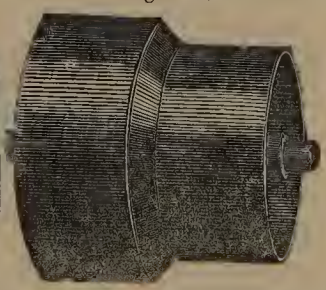
Loose Pin Hinge. One in which the leaves are detached by lifting out the pintle.

Fig. 1631.



Loose Pin Butt-hinge.

Fig. 1632.

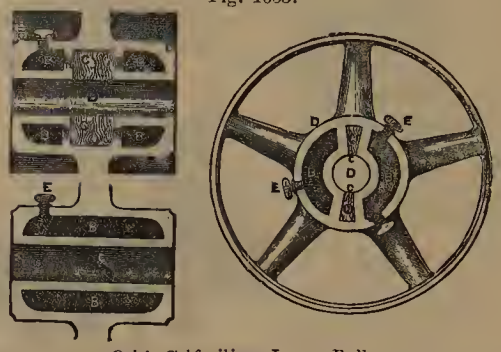


Streit's Pulleys.

Loose Pul'ley. A pulley running free on a shaft, and to which the belt is transferred when the machinery is to be stopped.

The pulleys shown in Fig. 1632 are fast and loose, the latter being the smaller one which is loose on the shaft. From it extends a flaring flange which expands to the diameter of the fast pulley so as to enable the belt to be readily slipped from one to the other. The object is to have the belt run slack when not driving the machinery.

Fig. 1633.



Otis' Self-oiling Loose Pulley.

In the *Otis'* self-oiling loose pulley, Fig. 1633, the hub is cored out to form an annular oil chamber *B* surrounding the bore; this communicates indirectly with the shaft *D* by the intervening supply chambers *C*, which are filled with wick which leads the oil from the reservoir to the shaft. Oil is supplied by exterior opening closable by screw plugs *E*.

The *Oesterline* loose pulley has a somewhat similar arrangement.

Davis, Br. . . . . * "*Engineering*," xxx. 349.
Fay . . . . . * "*Scientific American*," xxxvii. 294.
Kitson . . . . . * "*Engineering*," xxvii. 243.

Lor'gnon. A single eye-glass, also known as a *quizzing* glass.

Lost Mo'tion. Looseness of fitting, incident to wear of parts.

Lou-chettes'. Spectacles, or rather goggles, for strabismus; to constrain the eyes to assume the normal position with eyes front.

Fig. 1634.

Louchettes.

Loupe. Fr. A knot or burr on a tree from which veneers are cut for fancy furniture. Walnut, maple, oak, and other trees yield these curled excrescences. Remarkable specimens, some weighing, before dividing for transportation, as much as a ton, are shipped from Tiflis for the Paris market. They are steamed till soft and then cut into veneers by a shaving process.

Low Mil'ling. (*Milling.*) The system of close grinding as distinguished from HIGH MILLING, which see.

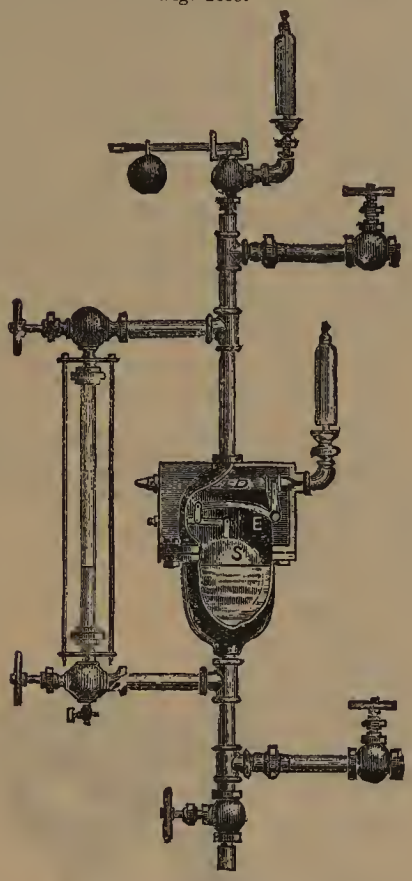
"The pointed or clipped grain is passed through stones at the nearest adjustment, by which it is at once ground to flour. It is practicable, however, by careful management of the working between the stones, to obtain a large part of bran and gluten-coats without disintegration, and to separate them from the flour by sifting, and this the more perfectly as by this process of milling finer sieves are employed. Still, it is not possible, at least it has not yet been shown, that this separation of the bran can be carried out so perfectly as to yield an *extract flour* of such fairness as is ordinarily obtained by the process of *high milling*. — *Horsford*.

See HIGH MILLING, pp. 457, 458, *supra*, where the question High Milling *v.* Low Milling is considered, and references are given to apparatus involved.

Low-wa'ter A-larm'. A device to sound an alarm when the water in the boiler sinks below the point of safety.

A number of devices, including those operating on the various principles, the float, the thermostat, and the fusible plug, are shown in Fig. 3008, p. 1359, "*Mech. Dict.*"

Fig. 1635.

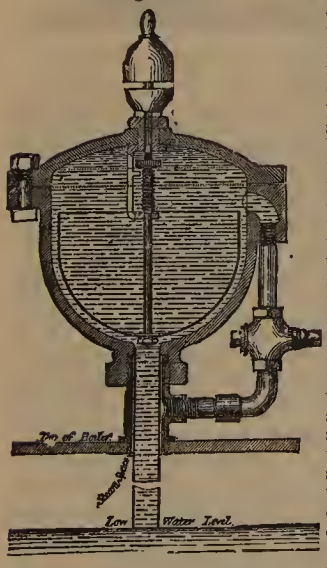


Low-water Alarm.

Myers' apparatus, on the float principle, is shown in Fig. 1635. A chamber intervenes between the boiler head and the gage-glass and contains a float *S* which descends when the water sinks below a certain level and by actuating levers withdraws the valve *D* and sounds a whistle.

See also GAGE GLASS, Fig. 1126, p. 365, *supra*.

Fig. 1636.



Kenyon's Low-water Alarm.

In *Kenyon's* low-water alarm, Fig. 1636, under ordinary conditions the pressure in the boiler forces the water up the inner pipe, and fills the outer vessel and suspended copper basin; but should the water in the boiler get below the bottom of the pipe, the water falls out of the vessel excepting the portion retained within the basin, which, acting as a dead weight, overcomes the slight resistance of the upward spring and the steam pressure, and pulls the plug away from the opening to the whistle, when the steam, rushing up the pipe, sounds the alarm. The apparatus can at any time be tested by turning the handle of the steam-cock upward, which places the interior of the vessel in a state of equilibrium, when the water falls to the level of that in the boiler (excepting that contained in the basin, which cannot escape), and the whistle is sounded; the vessel refills with water on closing the steam cock.

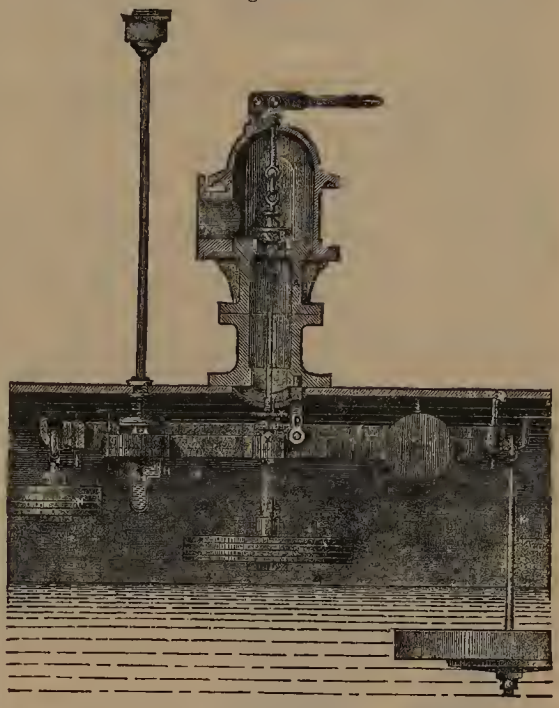
Hopkinson . . . . * "*Scientific American Sup.*," 2192.
Kenyon . . . . . * "*Engineering*," xxi. 168.
* "*Scientific American Sup.*," 319.
Myers . . . . . * "*American Miller*," vii. 97.
* "*Iron Age*," xx., July 26, p. 1.

See also LOW-WATER VALVE.

Low-wa'ter Valve. A valve which opens when the water in the boiler sinks below the level of safety. See LOW-WATER ALARM, Fig. 3008, p. 1359, "*Mech. Dict.*," and Fig. 1636, *supra*.

In *Hopkinson's* valve, shown at Fig. 1637, the working parts are within the boiler. In the form shown, it is a combined over-pressure and low-water valve. From one end of

Fig. 1637.



Valve for Over-pressure and Low Water.

the lever the float *F* is suspended at low-water level, and from the other end the counterbalance weights *N*. As long as *F* is immersed, and therefore partly carried by the water, the stop-pin at right-hand end of the lever will bear against shell of the boiler; but as soon as the water level sinks so that the float *F* is not any longer supported or only partly supported by the water, its preponderance over *N* will cause a pressure against *Y* and lift the valve. The arrangement which prevents over-pressure is shown at the other end: it is a species of safety valve of which *E* is the lever and *G* the counterbalance. At the other end of the lever is a cup, *H*, of mercury. When the pressure of steam is increased above a certain limit, a part of the mercury is displaced from the cup, and the lever, lightened at that end to that extent, rises and lifts the valve in the dome, allowing the steam to escape.

Lub'ber's Mark. (*Nautical.*) Of a compass. The black vertical mark in the compass-bowl in the direction of the ship's head, by which the angle between the magnetic meridian and the ship's course is shown.

Lu'bri-cant.

At a boiling heat stir together —

Petroleum	1 liter.
Graphite	88 grams.
Beeswax	3 grams.
Tallow	9 grams.
Caustic soda	3 grams.

Add to petroleum saturated solution of lime-water till the mixture becomes ropy, and then keep stirring till a drab color is acquired. 1 part may be added to the same amount of animal fat. — *Von Phul & Groat.*

Residuum of petroleum distillation, 160; compounded with pine tar, 15, boiled by steam heat and diluted with petroleum.

Petroleum, graphite, flour-sulphur, steatite, tallow, rock-salt, palm oil. — "*Amer. Manuf.*," "*Sc. Amer.*," xxxiv. 39.

Slaked lime, tar oil, resin oil, for slow-moving journals: caustic soda added for more rapidly moving objects. — *Newton*, Br.

Lu'bri-cant Al-loy'. An alloy of zinc, 7; copper, 4; tin, 1, resisted all turning tools till the edges were moistened with petroleum. The alloy then yielded readily. — "*Les Mondes.*"

Lu'bri-cant Test'er. A machine to test the quality of oil used for lubricating purposes.

Most of the machines are founded upon the same principle. The better the oil, the less the frictional adherence of two surfaces moving relatively and in contact with a given pressure upon them.

This may be evidenced in either of several ways: —

By the power required to produce the motion.

By pressure in the nature of a Prony brake to bring the motion to a halt.

By heat generated by the friction.

Deprez & Napoli's apparatus gives for the various oils a distinctive trace on properly ruled paper.

It has a lower revolving plate and an upper one supported upon it in such a manner that when oil is placed between the points of support of the upper plate and the lower plate, the tractile force upon the upper draws upon a steel ribbon connected to a pulley mounted on points, and to the axis of which is secured a pendulum. The rod of the latter carries a roller which engages upon a vertical piece attached to a carriage mounted on wheels which traverse rails. The carriage carries a sheet of paper against which is pressed a pencil which has a very slow motion of translation proportioned to the number of turns of the lower plate before mentioned, and the direction of the said motion is perpendicular to that of the carriage.

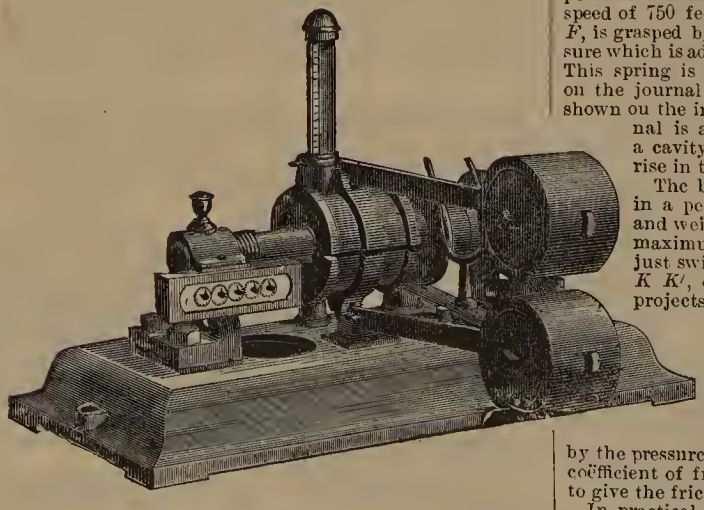
The curve traced on the paper by the composition of these two movements is the curve representing the value of the friction in terms of the number of turns made by the said lower plate

The tractile force is so much the greater as the lubricating quality of the oil decreases. See "*Scientific American*," xxxvi., 214. A still better view of the same, or of a machine with similar functions, is given on p. 360, vol. xl., *"*Scientific American.*" It appeared in "*Engineering*," and represents a machine employed by the Eastern Railway of France to ascertain the value of various lubricants, and was shown at the Paris Exposition of 1878.

An apparatus used by the Paris, Lyons, & Mediterranean Railway is shown at page 2794, *"*Scientific American Supplement.*" Two pairs of wheels on their axles are mounted in a frame, one above the other. Axle-boxes having been charged with the lubricant to be tested, the springs are raised by an arrangement of screws and worm wheels so that the axles of the upper shaft are lifted from the load. The wheels being rotated the springs are brought down, and that lubricant is the best which allows the heaviest pressure without heating.

Ashcroft's lubricant tester, Fig. 1638, consists of a shaft mounted on centers, so as to rotate freely, upon which shaft a drum is fixed, and revolves with the shaft. To this drum

Fig. 1638.



Ashcroft's Lubricant Tester.

brasses are neatly fitted, and held in position and pressed against the surface of the drum by levers and weights; and between the surfaces of the drum and of the brasses the oil is tested.

Upon the upper brass is a cup, which communicates with the surface of the drum, and into which the oil is dropped The shaft is rotated by a belt and pulley, and the number of revolutions is registered by a counter device operated by gearing from the shaft. Attached to the upper brass is a reservoir of mercury, into which a thermometer is adjusted, which indicates the heat generated by the frictional surfaces as the trial of the lubricant proceeds.

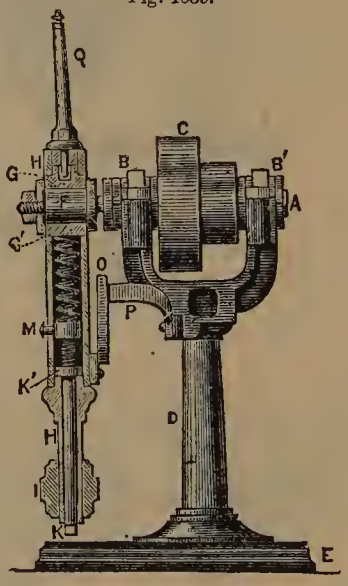
The principle upon which this machine is based is that of submitting a given quantity of the lubricant to be tested to a frictional action between cylindrical concaved and convexed surfaces under a fixed pressure, and then measuring the quantity of motion required to use up the given lubricant, determining the time when this is accomplished by the temperature of the frictional surfaces, which increases rapidly as the lubricant becomes exhausted.

Four drops of the lubricant to be tested are dropped into the cup from a glass dropping-tube, the temperature noted, the machine set in motion and allowed to run until the thermometer indicates a given degree of temperature at which it would be safe to run the machine — say 200° Fah. — as a standard; when it is stopped, and the number of revolutions taken.

The better the quality of the oil, the longer the machine will run before reaching that temperature. After each experiment the machine is taken apart, thoroughly cleaned, and allowed to cool to the surrounding temperature.

In order to test the "gumming" qualities of the oil, it is allowed to cool before cleaning.

Fig. 1639.



Thurston's Lubricant Tester.

The speed is about 1,400 revolutions per minute. On tests of various kinds of oils, the revolutions given varied from 11,250 to 15,300 before reaching the given temperature.

In Professor Thurston's lubricant tester the oil or other lubricant to be tested is placed on the journal *F*, which is on the overhung extremity of a shaft *A*, mounted in bearings *B*, *B*, on a standard, *D*, mounted on a base plate, *E*. The shaft is driven by a pulley, *C*, at any desired speed. A counter may be placed at the rear end of the shaft to indicate the number of revolutions. The shaft is usually driven at a fixed speed, corresponding to the velocity of rubbing surfaces approximating that of journals on which it is proposed to use the oil. In the inventor's practice, a standard speed of 750 feet per minute is adopted. The test journal, *F*, is grasped by bearings of bronze, *G G'*, and with a pressure which is adjusted by the compression of a helical spring. This spring is carefully regulated, and the total pressure on the journal and the pressure per square inch are both shown on the index plate by a pointer, *M*. Above the journal is a thermometer, *Q*, of which the bulb enters a cavity in the top brass, and which indicates the rise in temperature as wear progresses.

The brasses, thermometer, and spring are carried in a pendulum, *H*, to which the ball *I* is fitted; and weights are adjusted in such a manner that the maximum friction of a dry but smooth bearing shall just swing it out into the horizontal line. The stem, *K K'*, of the screw, which compresses the spring, projects from the lower end of the pendulum and can be turned by a wrench. A pointer, *O*, traverses an arc, *P*, and indicates the angle assumed by the pendulum at any moment. This angle is very large with great friction, and very small with good lubricating materials. This arc is carefully laid off in such divisions that dividing the reading by the pressure shown on the index gives the corresponding coëfficient of friction. The machine can also be arranged to give the friction directly.

In practical use, a standard quantity of oil is placed on the journal. The bearings are slipped on and set up to the

proposed pressure; the machine is started at the speed determined upon, and the observer notes the time, speed, pressure and temperature. These observations are repeated and recorded at regular intervals, and cease when a rapid rise of temperature to an objectionable or dangerous extent indicates that the lubricant has become destroyed.

See also Fig. 6330, p. 2539, "*Mech. Dict.*"

Another form, made by Bailey, of Salford, England, has a pendulum with a block on the end of a jointed arm, the block moving to and fro on a plate as the pendulum swings. The block and plate having been daubed with a definite amount of the lubricant, the pendulum is started in its oscillations, and the number of movements counted before it comes to rest. These will be fewer when the lubricant is the poorer.

Still another apparatus by Bailey is for testing the consistence of oils at given temperatures. A drop of oil is placed on the upper end of a slanting glass plate covering a heated tank. The distance which it will come down the glass is the measure of its consistence.

The form and size of a drop which drops from a pipette is an indication of quality at a given temperature.

Refer to: —

Ashcroft . . . . . * "*Railroad Gazette*," x. 511.
Bailey . . . . . * "*Engineer*," xlv. 372.
Bailey (2) . . . . . * "*Scientific American Sup.*," 2541.
Comparison of methods * "*Engineer*," xlv. 372.
Crossley . . . . . * "*Engineer*," xlv. 372.
Deprez & Napoli . . . * "*Scientific American*," xl. 360.
"*Scientific American*," xxxvi. 214.
Eastern Ry. of France . * "*Engineering*," xxvii. 234.
Electric tests . . . . "*Railroad Gazette*," xii. 242.
"*Min. & Sc. Press*," xxxviii. 351.
Evaporating point . . * "*English Mechanic*," xxiii. 86.
Flashing point . . . . * "*Engineer*," xlv. 372.
Friction brake . . . . * "*Engineer*," xlv. 372.
Hatcher . . . . . * "*Engineer*," xlv. 372.
Hodgman . . . . . "*Railroad Gazette*," xxii. 24.
Ingham & Stapfer . . * "*Railroad Gazette*," xxii. 24.
* "*Engineering*," xxiii. 28, 33.
McNaught . . . . . * "*Railroad Gazette*," xxii. 24.
Metcalf, paper by Lieut. * "*Ord. Report*," 1878, App. No. 2.
Napier . . . . . * "*Railroad Gazette*," xxii. 24.
Paper on . . . . . * "*R. R. Gaz.*," ix. 266, 492; x. 23.
"*Mining & Sc. Press*," xxxiii. 7; * xxxv. 177.
"*Am. Railroad Jour.*," li. 397.
Paris, Lyons & Med. Ry. * "*Engineering*," xxvii. 110.
* "*Scientific American Sup.*," 2794.
Pease . . . . . "*Scientific American*," xlii. 223.
Regray, E. Ry. of France * "*Engineer*," xlvi. 315.
"*Iron Age*," xxiii., Nov. 21, p. 15
Tagliabue . . . . . * "*Railroad Gazette*," xxii. 23.
Test for acids . . . . "*Man. & Builder*," ix. 240.
Tests for safety . . . "*Manufact. & Builder*," xii. 206.
Thermometrical . . . * "*Engineer*," xlv. 372.
Thompson . . . . . * "*Engineer*," xlv. 372.
Thurston . . . . * "*Engineer*," xlv. 372.
"*Railroad Gazette*," xxii. 23-25.
"*Mech. Dict.*," * Fig. 6330, p. 2539.
* "*Manuf. & Builder*," ix. 59, 131.
* "*Engineering*," xxiii. 176.
Trickling . . . . . * "*Engineer*," xlv. 372.
Bailey . . . . . * "*Scientific American Sup.*," 2541.
Withycomb, L. S. & Mich. Southern . . "*Railroad Gazette*," xxi. 266.

For exhaustive information on this subject reference is made to a lecture by Professor Thurston reported in "*Railroad Gazette*," xxii. 23, and well illustrated.

Lu'bri-ca'tor. 1. A device for greasing a journal, piston, or other moving part. Instances are given of *steam lubricators*, Fig. 3011, page 1361, "*Mech. Dict.*"; *axle-lubricators*, Fig. 3012, page 1362, and page 200, *Ibid.*; *hydrostatic lubricator*, Fig. 3013, page 1362, *Ibid.* See also PALIER GLISSANT, HYDRAULIC PIVOT; WATER BEARING; JOURNAL BEARING, etc. See also list of LUBRICANTS, page 1361, *Ibid.*

See LOCOMOTIVE CUP, *supra*; NEEDLE LUBRICATOR; OIL CUP; SHAFTING CUP; TALLOW CUP, *infra*.

2. (*Cartridge.*) A machine in which the bullets after being trimmed are waxed so as to clean the gun when firing. They are covered with Japan wax, which is in a vertical tube regulated by a heavy weight keeping it against the bullets which are fed in on a wheel. The bullets are pressed out carrying so much wax with them. See CARTRIDGE.

See Lubricant . . . . "*Scientific American Sup.*," 796.
Van Phul & Groat . "*Scientific American Sup.*," 692.
Lubricating oils . . . "*Sc. Am.*," xxxiv. 39; xxxvi. 79.
"*Scientific American Sup.*," 2541.
Lubricene, manuf. of . * "*Scientific American*," xl. 95.
Lubricator alarm signal.
Alley . . . . . * "*Scientific American Sup.*," 57.
Lubricator, steam.
Baines, Br. . . . . * "*Engineer*," xlvi. 165.
De Limon, Ger. . . * "*Engineering*," xxx. 398.
Galvin . . . . . * "*Am. Man.*," Feb. 14, 1879, p. 13.
Glydon, Br., steam . * "*Engineer*," xlvi. 368.
Harper, steam eng. . * "*Iron Age*," xix., April 19, p. 24.
Harrison, steam eng. * "*Scientific American*," xlii. 214.
Hoagland . . . . * "*Railroad Gazette*," xxi. 433.
Hughes, Br. . . . . * "*Engineering*," xxi. 492.
Hunt, Br. . . . . * "*Engineering*," xxiv. 399.
Johnson, cup . . . * "*Min. & Sc. Press*," xxxiv. 265.
Johnson . . . . . * "*Scientific American*," xxxv. 386.
Locomotive wheel flanges . . . . . * "*Engineer*," xlvii. 292.
Lonergan & McBride . * "*Iron Age*," xviii., Nov. 2, p. 5.
Parshall, cup . . . * "*Manuf. & Builder*," viii. 54.
Patrick, Ger. . . . * "*Engineer*," l. 165.
Paul . . . . . * "*Iron Age*," xxiv., July 24, p. 1.
Paulson, Br., pulsating * "*Engineering*," xxvi. 295.
Paulson, Engl. . . . * "*Scientific American Sup.*," 2436.
Loose pulley . . . . * "*Iron Age*," xxiii., May 8, p. 16.
Reed, Steam cyl. . . * "*Scientific American Sup.*," 715.
Thurston, Paper on . "*Scientific American Sup.*," 1110.

See article "*Graissage*," Laboulaye's "*Dictionnaire des Arts et Manufactures*," tome iv., ed. 1877.

Lu'bri-ca'tor A-larm' Sig'nal. A device to give an alarm when a journal becomes heated from absence of lubricant.

Alley's alarm is shown in Fig. 1640. The mode of action is as follows: The bell *B* is held in an elevated position by the composition plug *A*. If the supply of oil ceases from

Fig. 1640.

Lubricator Alarm Signal.

any cause the bearing heats and melts the plug. The bell *B*, thus losing its support, drops into gear with kicker *C* on the shaft *D*, rings, and continues to ring until the bearing is cooled down, and the plug renewed. These plugs are formed of hard, fatty matter, which melts at 130° Fah., the lubricant not taking fire until the temperature of the metal reaches 300° Fah. The substance of the plug running into the bearings prevents the evil from increasing before steps can be taken to reduce the heat.

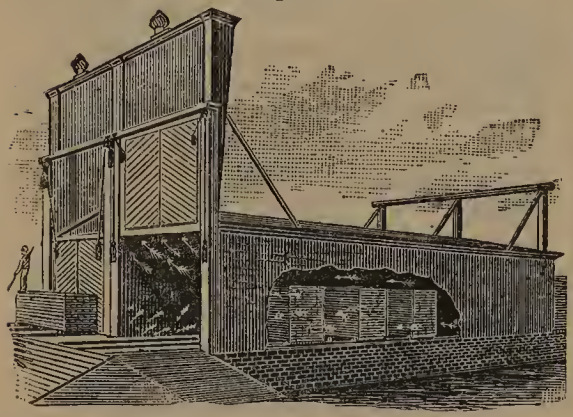
Luff Tack'le. (*Nautical.*) A tackle with a double and single block and a fall. *d*, Fig. 6159, p. 2480, "*Mech. Dict.*"

Luff-tack'le Pur'chase. (*Nautical.*) A form of tackle having a double block and a single one, known as a treble purchase. See *d*, Fig. 6159, "*Mech. Dict.*"

Lum'ber Dry'er. A drying kiln in which sawed lumber is dried artificially. Instances are given in Figs. 3014, 3015, pp. 1363, 1364, "*Mech. Dict.*"

Figs. 1641, 1642 show the "Excelsior" lumber dryer, which is a steam-heated house into which the lumber on

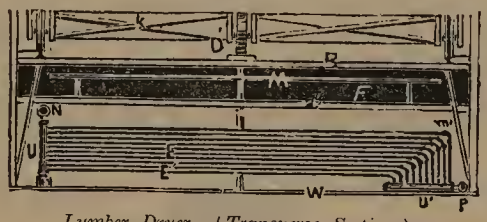
Fig. 1641.



"Excelsior" Lumber Dryer. (Perspective.)

trucks *D* is run upon rails. Underneath floor *B* of the lumber chamber is a dead-chamber, *F*, and still lower is the chamber heated by steam-pipes and coils *N*, *P*, *U*, *U'*, *E*.

Fig. 1642.

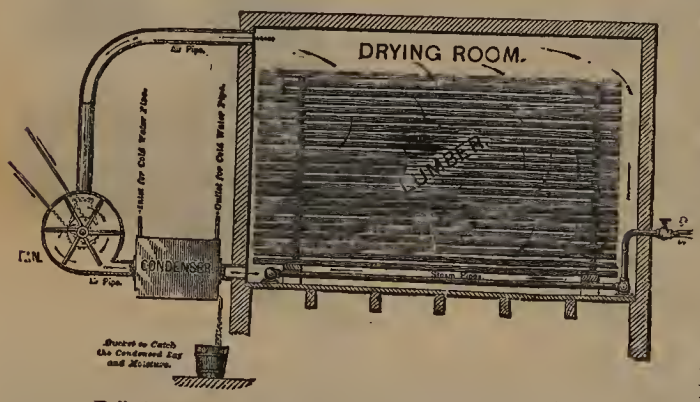


Lumber Dryer. (Transverse Section.)

The drying is by circulation of heated air which carries off the evaporated moisture.

Fig. 1643 shows Fuller's apparatus for drying lumber, in which the moisture is condensed; the room being tightly

Fig. 1643.

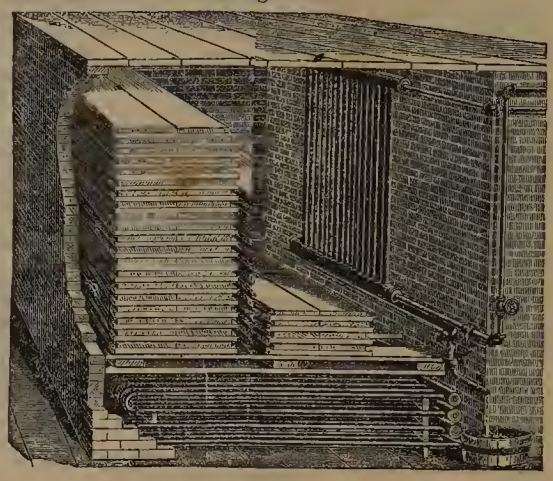


Fuller's Apparatus for Drying Lumber.

closed and steam-heated. The boards are placed in parallel rows with intervening spaces. A coil of steam-pipes is supported just above the floor of the room. From a point near the ceiling an air-duct leads to the fan; air is exhausted from the room and blown by the fan to the condenser, which is kept cool by a stream of cold water. The same air, deprived of moisture, is again driven into the lower stratum around the steam-pipes, and repeats its hydrophoric office.

Woods' lumber dryer, shown in Fig. 1644, has the artificial heater and the condenser in one tightly closed apartment, heated to 160° Fah., which in the illustration is shown as of very limited dimensions, but may hold ten or a dozen piles of lumber on the grated floor above the system of steam-pipes and coils in the basement. On the wall is seen the vertical system of water-pipes on which the moisture of the apartment condenses, and down which it trickles; being caught in a trough, it is conducted away. A stream of cold water constantly passes through the condenser pipes arranged against the wall.

Fig. 1644.



Woods' Lumber Dryer.

Lu'mi-nous Di'al. Recordon, of Paris, illuminates watches and clock dials by passing an electric discharge through a Geisler tube filled with a gas which yields a bright light. For a watch; a thimble cell of Trouvé is, together with a small induction coil, hung at the watch-chain. Pressing a spring completes the circuit and illuminates the dial.

A number of compositions of phosphorescent salts are given under DIAL, p. 254, *supra*.

Lu'mi-nous Buoy. 1. One which is luminous by night, to warn mariners from shoals.

2. One which is thrown into the sea and is self-lighting, or covered with a phosphorescent substance, as a guide to a person overboard.

A mode of automatic electric lighting of buoys, invented by M. de Lussex, of Belgium, consists in the employment of a Ruhmkorff coil in connection with a vacuum tube on the buoy as a lantern. The battery power is furnished by large plates of zinc and carbon, the sea-water acting as the exciting liquid. The induced current thus generated is said to be sufficient to light up the tube lantern so that it renders the buoy useful at night.—"*Engineering News.*"

Pintsch's buoy, for the same purpose, has a reservoir containing a quantity of condensed rich gas. Electric lighting apparatus is used. See BUOY, p. 147, *supra*.

Lieut. Cook's safety buoy is mentioned, p. 147, *supra*; also in "*Mech. Dict.*," p. 407. See also LIFE SAVING APPARATUS, *supra*.

Lu'mi-nous Paint. A phosphorescent paint to render an object visible at night.

English Patent 4,152, of 1877. Method of rendering paints, whitewashes, and temperings luminous, consists in introducing into ordinary paints, varnishes, or washes, a phosphorescent substance, with or without colors. The compound consists of lime and sulphur, or carbonate of lime and sulphur heated together. It is then mixed with colorless varnish, and may be applied to various articles by brush or by dipping, and to protect from weather is glazed over with a flux, as in enameling. Inventor mentions clock faces, thermometers, mariner's compass, cards, insides of railway cars, etc.

W. A. Caron, 121,703, Dec. 12, 1871. Door-plates having the letters of the name surrounded by an opaque surface, themselves being transpareut (or *vice versa*). A stick of phosphorus held against the rear of the plate by a spring, and packed in cement, so as to admit but a limited amount of air for the slow combustion of the phosphorus. Plate luminous by night.

Jules Peiffer, French *brevet*, Aug. 22, 1877. Certificate added Aug. 19, 1878. Application to various articles, under the name of "*Fulgore*," of phosphorescent substances to produce various colors in the dark after having been exposed to natural or artificial light. The *Fulgore* is made from the sulphides of barium, strontium, calcium, etc.

An English patent has a composition of carbonate of lime,

phosphate of lime, hydrate of lime, sulphur, sea salt, and almost any mono-sulphuret. Another has calcined shells, sulphur, arseniate of baryta, gum tragacauth, or sulphides of strontium, or barium with magnesia. See "*Sc. Am.*," xli. 248.

W. Trotter, No. 246,841, Sept. 6, 1881. Paint or composition of sulphide of calcium, and a vehicle consisting of a varnish made with gum mastic or other resiuous body, and turpentine or other spirit, or gelatine. May be mixed with various colors; is translucent and phosphorescent, and is intended to be applied to windows, to emit during the night the light stored up during the day.

Balmain's paint is a preparation of sulphide of calcium. See "*Engineering and Mining Journal*," xxix. 408.

On photographic paper weights. See "*Scientific American*," xlvi. 249. See also DIAL, p. 254, *supra*.

Lump. (*Fire-arm.*) The iron piece soldered on to the barrel, and which descends into the action (in break-joint breech-loaders) where there is a recess prepared for it.

Lu'na-tel'lus. An orrery showing the astronomical relations of the earth and moon.

Lung Test'er. A spirometer: an instrument for testing the capacity of the chest. Fig. 5431, p. 2279, "*Mech. Dict.*"

Burt . . . . . * "*Scientific American*," xxxv. 242.

Lus'ter. 1. (*Ceramics.*) Lusters are thin metallic surfacings to pottery which require no burnishing and in some cases have iridescent effects. They are placed on the ware with camel's hair pencil and the ware is fired in a muffle. They offer a cheap and brilliant effect with but little permanence. The following are the more usual; —

Gold luster is prepared by precipitating with ammonia the regal solution of gold, diluting the humid precipitate with turpentine and applying it without flux.

Platinum luster is obtained by a concentrated solution of chloride of platinum mixed with an essential oil.

Mother-of-pearl luster is obtained by precipitating by a weak acid a double sulphate of gold and potassium and grinding the precipitate with a little flux and essence of lavender.

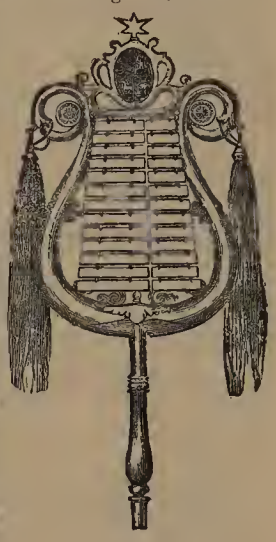
The *copper luster* of Spain is supposed to be produced by the silicate of the protoxide of copper; it is conjectured that the oxide is thrown into the furnace when the ware is fired.

Cantharides luster is obtained with a mixture of lead-glass and a little oxide of bismuth and chloride of silver. It is put on with the brush, the ware fired in the muffle from which it is withdrawn while red hot.

2. (*Fabric.*) A taffeta woven goods with cotton chain and long luster wool weft. A grade of alpaca.

Ly'ra. (*Music.*) An instrument with jingling plates. That shown in Fig. 1645 has two sets of steel bars, embracing two chromatic octaves1. For references to the various instruments which have bars in series sounded by percussion, and consisting of wood, metal, glass, stone, etc., see MARIMBA.

Fig. 1645.



Conn's Lyra.

Ly'sim'e-ter. A rain gage; pluviameter; ombrometer; udometer. See pp. 1871–1873, and Figs. 4145, 4146, "*Mech. Dict.*"

The lysimeter is designed to determine the amount and quality of the water which percolates through a certain depth of soil. By it a certain body of soil is so isolated without disturbing its natural condition that all the water percolating can be measured, and the heavy rains which in part flow over the surface of the soil may also flow over the lysimeter and not enter into the measure of effective rain. It consists of a box inclosing an undisturbed cube of earth, and a light bottom with a slant which directs the water to a measure placed below the drip, in a pit excavated at the side of the box. This method is in use at Rothamstead, England, and at "Houghton farm," Orange Co., N. Y.

Gage for temperature of rain, *Colladon* . . . * "*Scientific American Sup.*," 2746.
Rainfall . . . . . * "*Scientific American Sup.*," 1606.
Rain gage . . . . . * "*Scientific American*," xxxvi. 257.

M.

Ma-chine'. As distinct — on the one hand — from an engine: An instrument which fashions, or operates mechanically upon, objects or materials, and does not contain its own motor. It is driven by an engine or other motor, or by hand.

As distinct from a tool: It contains its own guide for operation.

A tool is a manual instrument depending for its efficiency upon the strength and skill of the operator.

A machine-tool is one which supersedes the hand tool formerly employed.

Instrument is a qualitative term, applied to tools and apparatus of delicacy and precision.

Some irregularities exist in the placing of these terms.

See under the following heads: —

Accumulator.
Adding machine.
Adjustable bed press.
Air compressing machine.
Air pump.
Air refrigerating machine.
Amalgamator.
Angle car-boring machine.
Angle cutting saw.
Angle-iron bending machine.
Angle shear.
Angle shearing machine.
Annealing machine.
Anvil.
Aplatisseur.
Apple grinder.
Arbor.
Arbor, expanding.
Arch screw-press.
Arm-boxing machine.
Army mill.
Artesian well machine.
Aspirator.
Aspirator winnowing mach.
Attrition mill.
Atmospheric hammer.
Axe-handle lathe.
Axle lathe.
Bait mill.
Balance-wheel turning mach.
Baling press.
Ball grinder.
Balling machine.
Ball trimmer.
Baluster lathe.
Band and jig saw.
Banding machine.
Band saw.
Band-saw mill.
Band-saw re-sawing machine.
Band-saw setter.
Band-saw setting machine.
Band-saw setting and filing m.
Band-saw sharpening frame.
Bar-cutting machine.
Barking machine.
Bark-mill.
Bark-rossing machine.
Baromotor.
Barrel-boring machine.
Barrel-chamfering machine.
Barrel crozing machine.
Barrel facing machine.
Barrel head.
Barrel head rounder.
Barrel hoop.
Barrel leveling machine.
Barrel leveling and trussing m.
Barrel machine.
Barrel pitching machine.
Barrel saw.
Barrel setting-up machine.
Barrel trussing machine.
Barrel turning lathe.
Barrel turning machine.
Barrel washer.
Barrel windlass.
Bar shear.
Beader.
Beaming machine.
Beam mill.
Bearing feeler.
Beating-out machine.
Beetling machine.
Beet grater.
Beet press.
Beet-root digger.
Beet-root machines.
Bell chuck.
Bench drill.
Bench-drilling machine.
Bending and straightening m.
Bending machine.
Bevel felly planer.
Bevel-gear cutting machine.
Bevel-gear wheel cutter.
Bevel rest for band-saw cut'g.
Bevel sawing machine.
Bevel-wheel cutter.
Binding machine.
Binding reaper.
Biscuit machine.
Blacking-box press.
Blacksmith's lathe.
Blank-work folder.
Blanking press.
Blind-lath punching mach.
Blind-relishing machine.
Blind-slat crimping machine.
Blind-slat mortising mach.
Blind-slat planer.
Blind-slat router.
Blind-slat tenoning machine.
Blind-stile borer and mortiser.
Blind-stile boring machine.
Blind-stile mortising mach.
Blind wiring-machine.
Blocking machine.

Block ironing machine.
Block-making machine.
Blower.
Blubber mincing machine.
Board-cutting machine.
Board-seasoning machine.
Boiler-plate clipper.
Boiler prover.
Boiler-shell drilling machine.
Boiler smith.
Bolt clipper.
Bolt-cutting machine.
Bolt die.
Bolt-forging machine.
Bolt-heading machine.
Bolt holder.
Bolt-pointing machine.
Bolt-trimming machine.
Bolt-turning lathe.
Bone mill.
Book-backing machine.
Bookbinding press.
Book-sawing machine.
Book-sewing machine.
Book trimmer.
Boot-cleaning machine.
Boot machine.
Boot-sewing machine.
Boring-and-turning mill.
Boring machine.
Boring mill.
Bottle washer.
Bottling machine.
Box-board machine.
Box-board matching mach.
Box-forming machine.
Boxing machine.
Bracket cutting-off saw.
Braiding machine.
Bran duster.
Brass-finisher's lathe.
Breaking-down machine.
Break lathe.
Brick machine.
Brick press.
Brick re-pressing machine.
Brim-pouncing machine.
Brim stretcher.
Broaching press.
Broadcast seeder.
Bronzing machine.
Broom-corn scraper.
Broom-handle lathe.
Broom-sewing machine.
Broom trimmer.
Broom winder.
Brush-finishing machine.
Brushing machine.
Brush machine.
Buckwheat huller.
Buckwheat shucker.
Buffing lathe.
Buffing machine.
Bullen nail machine.
Bullet machine.
Bullet patching machine.
Bung lathe.
Bung machine.
Burring engine.
Burring picker.
Butter worker.
Butt lathe.
Buzzer.
Buzz planer.
Cable-testing apparatus.
Cacao sorter.
Cake breaker.
Cake grinder.
Calculating machine.
Calendering machine.
Calender rolls.
Calico-printing machine.
Caliper machine.
Cambering machine.
Cam-cutting machine.
Cameo press.
Cam loom.
Cam press.
Cam-body former.
Candle machine.
Candle-polishing machine.
Candy-rolling machine.
Candy slicer.
Cane mill.
Can-labeling machine.
Canting table.
Capstan.
Car-axle lathe.
Car boring machine.
Car-box drill.
Car-box grinding machine.
Carburetor.
Card and ticket cutter.
Cardboard cutter.
Cardboard machine.
Card grinder.
Cardigan-jacket machine.
Carding machine.
Car gaining machine.
Car-journal-bearing boring m.
Car mortising machine.
Carpet loom.
Carpet match'g & meas'g m.
Carpet winder.
Carriage cutting-off saw.
Carrier.
Car sill dressing machine.
Car sill machine.
Car tenoning machine.
Cartridge heading machine.
Cartridge head tester.
Cartridge loading machine.
Cartridge varnishing machine.
Car-truck-frame drilling m.
Carving lathe.
Carving machine.
Car-wheel balancing apparat.
Car-wheel borer.
Car-wheel chuck.
Car-wheel grinding machine.
Car-wheel press.
Car washing machine.
Case trimmer.
Cash recording machine.
Cask leveling machine.
Cement chuck.
Cement mill.
Cement testing machine.
Centering chuck.
Centering lathe.
Centering machine.
Centering tool.
Center plate.
Center sawing machine.
Centrifugal machine.
Chaff cutter.
Chaff sifter.
Chain cable shear.
Chain loom.
Chain testing machine.
Chair mortiser.
Chamfering machine.
Change wheels.
Charcoal grinding mill.
Charcoal washer.
Chaser.
Chasing lathe.
Cheese press.
Chemical fire engine.
Chilian mill.
Chocolate machine.
Chocolate mixer.
Chopping mill.
Chop separator.
Chromo-lithographic machine.
Chucking lathe.
Chucking machine.
Cider mill.
Cider press.
Cigarette machine.
Cigar mold.
Circular knitting machine.
Circular resawing machine.
Circular ribbing machine.
Circular saw.
Circular saw mill.
Clamp milling machine
Clapboard machine.
Clay mill.
Clipping machine.
Clipper.
Clod crusher.
Closing machine.
Cloth cutting machine.
Cloth dressing machine.
Cloth drying machine.
Clothes wringer.
Cloth finishing machine.
Cloth folding machine.
Cloth measuring apparatus.
Cloth press.
Cloth pressing machine.
Cloth shearing machine.
Cloth stretching machine.
Cloth testing machine.
Cloth wind'g and measur'g m.
Clover huller.
Coal cutting machine.
Coal mining machine.
Coal testing machine.
Coal tipping machine.
Coal washer.
Cockle separator.
Cocoon winder.
Coffee cleaner.
Coffee cooler.
Coffee dryer.
Coffee huller.
Coffee grinder.
Coffee mill.
Coffee roaster.
Coiling apparatus.
Coiling machine.
Cold air machine.
Cold saw.
Collar machine.
Combing machine.
Composing machine.
Compound cotton press.
Compound lathe.
Concasseur.
Cooperage machine.
Cop reel.
Cop winding machine
Copying lathe.
Copying machine.
Cord-making machine.
Cork-cutting machine.
Corking machine.
Cork machine.
Corkscrew machine.
Corn cleaner.
Corn cracker.
Corn cutter.
Corn drill.
Corn husker.
Cornice machine.
Corn mill.
Corn planter.
Corn sheller.
Corn stalk cutter.
Corset loom.
Corundum wheel.
Cotton gin.
Cotton opener.
Cotton picking machine.
Cotton planter.
Cotton press.
Cotton seed huller.
Coupon numbering machine.
Coupon ticket machine.
Crab.
Cracker cutting machine.
Cracking machine.
Cranberry picker.
Crane.
Crank lathe.
Crank-pin driver.
Crank-pin jack.
Crank-pin turner.
Creeper.
Crimp brake.
Crimper.
Crimping machine.
Cross-cut circular saw.
Cross-cut saw.
Cross gaining machine.
Cross raising machine.
Crown pouncing machine.
Crozing machine.
Crusher.
Crushing mill.
Cube sugar machine.
Cuff frame.
Cultivator.
Cupping machine.
Cushioned hammer.
Cut-off saw
Cutter grinder.
Cutting and drawing press.
Cutting and screwing mach.
Cutting and stamping press.
Cutting-off lathe.
Cutting-off machine.
Cutting-off saw.
Cutting-off shear.
Cut-off saw.
Cutting press.
Cylinder boring machine.
Cylinder boring and facing m.
Cylinder fixing apparatus.
Cylinder forging mill.
Cylinder grinding mill.
Cyliuder saw.
Cylindrical saw.
Darning machine.
Dead-stroke hammer.
Decorticator.
De-gumming machine.
Dental engine.
Diagonal planing machine
Diamond drill.
Dielectric machine.
Die-sinking machine.
Diffusion apparatus
Dimension saw.
Dirt scraper.
Disintegrator.
Disking machine.
Ditching machiue.
Dividing engine.
Dobby machine.
Domestic motor.
Door and sash tenoning mach.
Door clamp.
Door mortising machine.
Door relishing machine.
Double cutting-off machine.
Double edging machine.
Double-face milling machine
Double pitman press.
Double planing machine.
Double seamer.
Double surfacing machine.
Double traverse drill.
Double-tub press.
Double wheel lathe.
Double winding machine.
Dough brake.
Dough kneader.
Dough mixer.
Dovetailing machiue.
Dowel machine.
Drain-tile machine.
Drawing frame.
Drawing machine.
Drawing press.
Dredging machine.
Drill grinder.
Driller and slotter.
Drilling machine.
Drill press.
Drop hammer.
Dropper.
Drop press.
Drug mill.
Drying machine.
Duplex boring and facing m.
Duplex boring and turning m.
Duplex planing machine.
Duplex punch.
Duplex slide rest.
Dusting machine.
Dye-wood cutter.
Dye-wood grinder.
Dynamo-electric machine.
Dynamometer.
Earth borer.
Earth scraper.
Eccentric chuck.
Eccentric lathe.
Eccentric mill.
Economizer.
Edge molding and shaping m.
Edge molding machine.
Edge planing machine.
Edger.
Edge setter.
Edge trimmer.
Edging machine.
Edging saw.
Electrical machine.
Electro-magnetic machine.
Electrotype molding machine.
Embossing machine.
Embossing press.
Embroidering machine.
Emery grinder.
Emery planer.
Emery wheel.

Emery wheel dresser.
Endless-bed planer.
Endless-belt grinder.
Endless saw.
Engine lathe.
Engraving machine.
Ensilage cutter.
Envelope machine.
Envelope printing press.
Epicycloidal milling engine.
Evaporator.
Excavator.
Exercising machine.
Exhaust fan.
Expanding mandrel.
Expansion boring tool.
Face lathe.
Facing machine.
Faller machine.
Fancy broad loom.
Fanning mill.
Farm mill.
Feed cutter.
Feed mill.
Feed regulator.
Felling saw.
Felly bending machine.
Felly boring machine.
Felly-rim planing machine.
Felly rounding machine.
Felly saw.
Felting machine.
Fencing machiue.
Fertilizer distributor.
Fertilizer mill.
Fertilizer sower.
Filter press.
Finishing press.
Fire engine.
Fire-hole ring riveter.
Fire pot.
Fish dressing machine.
Flanging machine.
Flat rib knitting machine.
Flax braking machine.
Flax loom.
Floor boring machine.
Flour bolt.
Flouring mill.
Flour packer.
Flue cutter.
Fluting machine.
Flying sounder.
Fodder cutter.
Fodder mill.
Folder.
Folding machine.
Folding and perforating m.
Foot band-saw.
Foot die machine.
Foot drill.
Foot lathe.
Foot press.
Foot punching press.
Forage cutter.
Forage press.
Force.
Forge.
Forge hammer.
Forging, hydraulic.
Forging machine.
Forming machine.
Forming press.
Foulard machine.
Four-high mill.
Four-spindle drill.
Four-screw chuck.
Frame drilling machine.
Frame planing machine.
Frame slotting machine.
Fret saw.
Fret scroll saw.
Friction machine.
Friction-roller drop.
Fruit press.
Fruit separator.
Fulling mill.
Fur blowing machine.
Fusing disk.
Gage lathe.
Gage table-shears.
Gang drill.
Gang edger.
Gang plow.
Gang ripping saw.
Gang saw.
Gap-bed lathe.
Gap lathe.
Gas machine.
Gate saw.
Gear cutter.
Gear-wheel dresser.
Geometric lathe.
Gibbed engine-lathe.
Gilding press.
Gingham loom.
Girder riveter.
Girder tester.
Glass-polishing machine.
Glass press.
Glove making machine.
Glove sewiug machine.
Gorse cutter.
Grader.
Grading plow.
Grain cleaner.
Grain crusher.
Grain cutter.
Grain drill
Grain dryer.
Grain mill.
Grain scourer.
Grain screen.
Grain separator.
Grain sifter.
Grain smutter.
Grain sorter.
Grain steamer.
Grain toller.
Grain washer.
Grain weigher.
Granulating machine.
Grape crusher.
Grape mill.
Grape press.
Grapple dredging machine.
Grinder.
Grinding lap.
Grinding machine.
Grinding mill.
Grinding wheels.
Grindstone turning device.
Grist mill.
Grits grading machine.
Grits mill.
Grits purifier.
Grooving and beading mach.
Grounding machine.
Gummer grinder.
Gumming machine.
Guu stocking machine.
Hand bolt cutter.
Haud loom.
Hand mortising machine.
Hand planer.
Hand rock-drill.
Hand-strap apparatus.
Hand milling machine.
Hand plan.
Hank dyeing machine.
Hardening machine.
Harvester.
Hat blocking machine.
Hat finishing lathe.
Hat forming machine.
Hat lining sewing machine.
Hat press.
Hat shaping machine.
Hat shaving machine.
Hat stiffening machine.
Hat stretcher.
Hay loader.
Hay press.
Hay rake.
Hay tedder.
Head beveling and turning m.
Heading clipper.
Heading dresser.
Heading jointer.
Heading machine.
Heading planer.
Heading rounder.
Heading saw.
Heading turner.
Headstock.
Heel attaching machine.
Heel breasting machine.
Heel building machine.
Heel burnishing machiue
Heel cutter and shaper.
Heel filing machine,
Heel jack.
Heel machinery.
Heel scouring machine.
Heel trimmer.
Helve hammer.
Hemp softening machine.
Hoeing machine.
Hogshead machinery.
Hoisting apparatus.
Hollow spindle lathe.
Hominy machine.
Hominy mill.
Honey extractor.
Hoop.
Hoop and splint machine.
Hoop banding machine.
Hoop making machine.
Hoop-pole river.
Hoop punch'g, flar'g, etc., m.
Hoop punching machiue.
Hop picker.
Horizontal boring machine.
Horizontal boring mill.
Horizontal mortising mach.
Horizontal saw mill.
Horizontal slot boring mach.
Horn press.
Horse groomer.
Horse hay-fork.
Horse hoe.
Horse power.
Horse rake.
Hosiery seaming machine.
Hot curving machine.
Hot-iron saw.
Hot press.
Hot saw.
Hot straightening machine.
Hub boring machine.
Hub boxiug machine.
Hub mortising machine.
Huller.
Howeling machine.
Hydraulic bender.
Hydraulic boring machine.
Hydraulic coal miner.
Hydraulic crane.
Hydraulic electric machine.
Hydraulic elevator.
Hydraulic engine.
Hydraulic forging.
Hydraulic punch.
Hydraulic press.
Hydraulic riveter.
Hydro-extractor.
Hydrostatic weighing mach.
Ice machine.
Impression machine.
Impression stitch machine.
Inclined press.
Incorporating mill.
Incubator.
Index milling machine.
Independent drill.
Ink grinding machine.
Insect destroyer.
Inside molding machine.
Intermediate spinning frame.
Iron cutter.
Iron cuttiug saw.
Irouing machine.
Iron saw.
Iron shears.
Jacquard loom.
Jigging machine.
Jig saw.
Joiner.
Jointer.
Jute machinery.
Keg jointer.
Keg leveling and trussing m.
Keg machine.
Key grinder.
Key seat cutting machine.
Key way cutter.
Kibbling mill.
Kneading machine.
Knife-grinding machine.
Knitting machine.
Labeling machine.
Laboratory lathe.
Lag machine.
Lap doubling machine.
Lap machine.
Lard press.
Lathe.
Lawn mower.
Lead-pipe machine.
Leather finishing machine.
Leather glazing machine.
Leather pebbling machine.
Leather raising, etc., mach.
Leather scouring machine.
Leather splitting machine.
Leather stamping machine.
Leather stretching machine.
Leather whitening machine.
Lever drill.
Lever press.
Lever punch.
Levigating machine.
Lifting machine.
Lime cracker.
Lime mill.
Lithographic press.
Lithographic stone dresser.
Lithog. stone polish'g mach.
Litter cutter.
Loading machine.
Lock mortising machine.
Log butter.
Log frame.
Log roller.
Loom.
Lozenge machine.
Lubricant tester.
Lubricator.
Magneto-electric machine.
Main tapping machine.
Maize cutter.
Maize mill.
Malaxator.
Malt crusher.
Mandarining machine.
Mandrel press.
Mangle.
Marking machine.
Masticator.
Matcher and jointer.
Matcher setter.
Matching machine.
Match-making machine.
Matrix rolling machine.
Meal cooler.
Measuring machine
Meat chopper.
Meat stuffer.
Medal lathe.
Metal saw.
Middlings grinder.
Middlings mill.
Middlings purifier.
Middlings softening machine.
Milk skimming machine.
Mill.
Mill dog.
Mill grinder.
Milling machine.
Milling rollers.
Mill-pick sharpener.
Mill-stone dresser.
Mill-stone facing machine.
Mineral dresser.
Mining machine.
Mitering machine.
Mixing machine.
Mixing mill.
Molding machine.
Molding-iron grinder.
Molding, shaping, etc., mach.
Monogram machiue.
Monogram press.
Monte-jus.
Mortar mill.
Mortar mixer.
Mortising chisel
Mortising machine.
Mouthing machine.
Mulay-saw mill.
Mule.
Multicolor printing press.
Multiple drilling machine.
Multiple wheel tool grinder.
Nail picker.
Nail polishing cylinder
Nap meter.
Navigational sounding mach.
Needle making.
Needle straightener.

Net machine.
Notching machine.
Nut tapping machine.
Oat mill.
Oat separator.
Oil-cake breaker.
Oil cake mill.
Oil press.
Oil testing machine.
Olive press.
Open back press.
Open die machine.
Opener-tapper.
Opening machiue.
Ore breaker.
Ore crusher.
Ore dryer.
Ore grinder.
Ore mill.
Ore separator.
Ore sifter.
Ore washer.
Organ blower.
Outside molding machine.
Outside tacking machine.
Oval lathe.
Oval tenon machine.
Overpick loom.
Overshot separator.
Pail and tub machinery.
Painting machine.
Paint mill.
Pauel-board molding mach
Panel machine.
Panel molding machine.
Panel planer.
Panel raiser.
Panning machine.
Pantograpbic cutter-former.
Pantographic engrav. mach.
Paper bag machine.
Paper calendering machine.
Paper clippiug machine.
Paper collar machine.
Paper coloring machine.
Paper cutting machinc.
Paper cutter and winder.
Paper glazing machinc.
Paper knife grinder.
Paper press.
Paper pulp machine.
Paper rolling machine.
Paper testing machine.
Pasteboard cutter.
Pattern maker's lathe.
Peat machine.
Pebble-powder machine.
Pebbling machine.
Pellet-powder machine.
Pegging machine.
Pendulum press.
Perambulator.
Perfecting press.
Perforating machine.
Picket heading machine.
Picket sawing machine.
Pig-iron breaker.
Pile driver.
Pile driving engine.
Pillar drilling machine.
Pillar shaper.
Pin making machine.
Pipe beuder.
Pipe cutting machine.
Pipe elbow-bender.
Pipe prover.
Pipe screwing machine.
Pistol rifling machine.
Pitman press.
Pivot polisher.
Plaiting machine.
Planing machine.
Planing, chamfering, etc., m.
Planishing hammer.
Planter.
Plastering machine.
Plaster mill.
Plate-bending machine.
Plate machine.
Platc pickling machine.
Plate press.
Plate sbearing machine.
Plate welding hammer.
Plow. (Varieties: sec list.)
Plow grinder.
Plow-handle bending mach.
Plow-handle lathe.
Pneumatic excavator.
Pointing machine.
Polishing machine.
Portable cider press.
Portable circular saw mill.
Portable drilling machiue.
Portable grist mill.
Portable mill.
Portrait lathe.
Positive motion loom.
Post drill.
Potato bug destroyer.
Potato digger.
Potato planter.
Potter's wheel.
Pottery mill.
Pouncing macbine.
Powder-pressing machine.
Power press.
Power shears.
Press drill.
Pressing machine.
Pressure bar.
Pressure block.
Pressure blower.
Priming machine.
Printing machiue.
Printing press.
Print washing machine.
Profiling machine.
Proof press.
Puddling machine.
Pug mill.
Pulley boring machine.
Pulley grinding machine.
Pulley-head mortising mach.
Pulley lathe.
Pulley turning machine.
Pulverizer.
Pulverizing mill.
Pump. (Varieties, see list.)
Pump joint machine.
Punch and shear.
Punching machine.
Punching press.
Pusher.
Quick-speed drill.
Race.
Rack cutting machine.
Radial drilling machine.
Radius cross-cut sawing m.
Radius planer.
Rag duster.
Rag and waste picker.
Rag picker.
Rag washer.
Rail bender.
Rail borer.
Rail shears.
Rail slitter.
Railway crane.
Railway cutting-off saw.
Railway speed recorder.
Ramie fiber machine.
Rand breasting machine.
Rand turning machine.
Ratchet drill.
Reciprocating planing mach.
Reducing press.
Relishing machine.
Re-pressing brick macbine.
Re-pressing machine.
Re-sawing band saw.
Re-sawing machine.
Revolving head screw mach.
Revolving tool-head screw m.
Rheostatic machine.
Rib fabric knitting machine.
Rib-top machine.
Rice drill
Rice huller.
Rice thresher.
Riddle sorter.
Ridge-stone cutting machine.
Rifling machine.
Rim planer.
Rim-saw machine.
Ring and traveler frame
Ring saw machine.
Rinsing machine.
Ripping saw.
Riveting machine.
Riveting machine, hydraulic.
Riveting press.
Road locomotive.
Road roller.
Road scraper.
Rock borer.
Rock breaker.
Rock crusher.
Rock drill.
Rocking saw-table.
Rod machine.
Rod, pin, and dowel machine.
Rod planer.
Roller mill.
Rolling machine.
Rolling mill.
Root cutter.
Root grinder.
Root puller.
Root pulper.
Root shredder.
Root slicer.
Root washer.
Rope molding machine.
Rosette cutter.
Rosette lathe.
Rossing machine.
Rotary-bed planing machine.
Rotary mortising machine.
Rotary shaper.
Rotator.
Rounding machine.
Routing machine.
Roving frame.
Rule and lead cutter.
Ruling machine.
Sabot machine.
Sail sewing machinc.
Sand-papering machine.
Sash machine.
Sash molding machinc.
Sash mortising machine.
Sash relishing machinc.
Sash sticking machine.
Satinet loom.
Sausage stuffer.
Saw filer.
Saw gummer.
Saw gumming emery wheel.
Saw gumming press.
Sawing and boring machine.
Sawing engine.
Sawing machine.
Saw jointer.
Saw mill.
Saw sharpening machine.
Saw toothing machiue.
Scarifier.
Scrap-cutting machine.
Scraper.
Scraping machine.
Screw and nut machine.
Screw cutting lathe.
Screw cutting machine.
Screw finishing machine.
Screw hoist.
Screwing machine.
Screw machine.
Screw nicking machine.
Screw polishing machine.
Screw press.
Screw shaving machinc.
Screw slotting machine.
Screw soling machine.
Screw-thread forging mach.
Screw-wire soling machine.
Scroll lathe.
Scroll saw.
Scrubbing machine.
Sculpture machine.
Seal-embossing press.
Seaming, etc., machine.
Seaming machine.
Sectional mill.
Seed drill.
Seeding machine.
Segment saw.
Self-acting drilling machine.
Self-acting lathe.
Semolina machine.
Semolina separator.
Separator.
Serpentine molding machine.
Sewing machine.
Shaft boring apparatus.
Shaft excavator.
Shaft straightener.
Shaper.
Shaping machine.
Shaving machiue.
Shawl loom.
Shearing machine.
Shear, punch, and upsetter.
Sheep-shearing machine.
Sheet calender.
Shingle machinc.
Shingle and heading macbine.
Shingle buncher.
Shingle sawing machine.
Ship-timber saw.
Shirt frame.
Shirt knitting machine.
Shoddy machine.
Shoe embossing machine.
Shoe sewing machine.
Shoe nail machine.
Shoe pegging machine.
Shoe soling machine.
Shoot board.
Shuttle race milling mach.
Sickle grinder.
Side planing machine.
Sifting machine.
Silk de-gumming machiue.
Silk dyeing machine.
Silk loom.
Silk reel.
Silk softening machine.
Silk spinner.
Silk spooling machine.
Silk stretching machine.
Silk testing machine.
Silk washing machine.
Silk winder.
Singeing machine.
Single speed drilling mach.
Skein setter.
Skein torsion machine.
Skin-beating machine.
Skiving machine.
Slabbing machine.
Sleeper recessing machine.
Sleeve machiue.
Slitting mill.
Slitting saw.
Slitting shear.
Sliver lap machine.
Slot-boring machine.
Slot-drilling machine.
Slotting machine.
Slubbing frame.
Smashing press.
Smoothing machine.
Smut machine.
Smutter.
Snap machine.
Soap machine.
Soda water machinery.
Soil pulverizer.
Solder cutter.
Soldering machine.
Sole cutter.
Sole cutting press.
Sole forming machine.
Sole leather roller.
Sole-leather stripping mach.
Sole moldiug machine.
Sole press.
Sole riveting machine.
Sole rolling machine.
Sole screwing machine.
Sounding apparatus.
Specific gravity machine.
Speed indicator.
Speed lathe.
Sphere-turning lathe.
Spice mill.
Spinning head.
Spinning lathe.
Spinning machine.
Spinning mule.
Spiral spring coiling machine.
Splining machine.
Splint cutting machine.
Splitting machine.
Splitting saw.
Spoke driving machine.
Spoke facing and jointing m.
Spoke lathe.
Spoke polishing machine.
Spoke setting machine.

Spoke tenoning machine.
Spoke tenou trueing mach.
Spoke throating machine.
Spoke turning lathe.
Spooling machine.
Spool printing machine.
Spool winding machine.
Spraying machine.
Spring adjuster.
Spring shaping machine.
Spring steam hammer.
Spring testing machine.
Square arbor lathe.
Squaring-off saw.
Squaring shear.
Squeezer.
Stalk cutter.
Stamping and cutting press.
Stamping machine.
Stamping mill.
Stamping press.
Staple machine.
Starching machine.
Stationary bed planer.
Stave cutter.
Stave dressing machine.
Stave ending machine.
Stave bolt equalizer.
Stave equalizer.
Stave jointer.
Stave machine.
Stave planer.
Stave saw.
Steam capstan.
Steam crane.
Steam hammer.
Steam plate press.
Steam plow.
Steam reaper.
Steam riveting machine.
Steam stamp.
Steam winch.
Stearine press.
Steel hammer.
Stereotype beveling machine.
Stiffening machine.
Stock turning lathe.
Stone boring and facing m.
Stone breaker.
Stone channeling machine.
Stone clearer.
Stone cleaving machine.
Stone crusher.
Stone cutting machine.
Stone dressing machine.
Stone drill.
Stone molding machine.
Stone planing machine.
Stone sawing machine.
Stone splitting machine.
Stoping drill.
Stove-plate dressing mach.
Straight cutter planing m.
Straighteuing machine.
Straw cutter.
Street sweeper.
String binder.
Stripper.
Stripping machine.
Stud turning lathe.
Stuffing machine.
Stump extractor.
Submarine excavator.
Sugar-cane mill.
Sugar dryer.
Sugar evaporator.
Sugar filter.
Sugar-top cutter.
Surface grinding machine.
Surface molding and edg'g m.
Surface planing machine.
Surfacing lathe.
Surfacing machine.
Sweat-rolling machine.
Sweat sewing machine.
Sweeping apparatus.
Sweet potato digger.
Swing saw.
Tack machine.
Tacking machine.
Tailor's pressing machine.
Talc mill.
Tanite machine.
Tan press.
Tapering and crimping mach.
Tap groove sharpening mach.
Tap grooving machine.
Tapping machiue.
Tea preparing machine.
Teaseling machine.
Tedder.
Teuoning machine.
Tentering machine.
Testing machine.
Thatch-making machine.
Thread cutting machine.
Thread dressing machine.
Threading machine.
Thread waxing machine.
Three-spindle drilling mach.
Threshing machine.
Tile machine.
Tip stretcher.
Tire bender.
Tire grinding apparatus.
Tire grinding lathe.
Tire setter.
Tire shrinker.
Tire upsetter.
Tobacco-cutting machine.
Tobacco granulating mach.
Tobacco press.
Tobacco spinning machine.
Tobacco stripper.
Toggle press.
Tolling machine.
Tool-grinding machine.
Tool-sharpening machine.
Tooth cleaner.
Track-laying machine.
Transfer lathe.
Transverse planing machine.
Traveling-bed planer.
Traverse drill.
Traverse planer.
Traverse slotting machine.
Traversing sawing machine.
Treadle circular saw.
Treadle drilling machine.
Tread power.
Trimmer.
Trip hammer.
Truss-hoop driver.
Trussing machine.
Trying-up machine.
Tube drawing machine.
Tunneling machine.
Turbine.
Turning mill.
Turning-off machine.
Turn-over gear.
Turret lathe.
Turret screw machine.
Twin power press.
Twist drill grinding machine.
Two-box loom.
Two revolution press.
Two spindle shaper.
Tying-in machine.
Type machine.
Type making and setting m.
Type writer.
Unhairing machine.
Universal borer.
Universal emery grinder.
Universal lathe.
Universal milling machine.
Universal wood-worker.
Upright drill.
Upright molding machine.
Upright shaper.
Upsetting machine.
Valve refitter.
Valve-seat planer.
Vanning machine.
Vegetable cutter.
Veneer cutter.
Veneer sawing machine
Ventilator.
Vertical boring machine.
Vertical-buhr mill.
Vertical car-boring machine.
Vertical car tenoning mach.
Vertical drilling machine.
Vertical mill.
Vertical molding machine.
Vertical re-sawing machine.
Vertical-stone mill.
Wall drilling machine.
Wall paper machine.
Wall-paper polishing mach.
Wall-paper sticking mach.
Warping machine.
Warp tying machine.
Washing machine.
Waste picker.
Watchmaker's lathe.
Water aërating apparatus.
Water motor.
Wave molding machine.
Wax-thread sewing machine.
Web printing press.
Wedge cutter.
Weighted-carriage lathe.
Welding press.
Well drill.
Welt machine.
Wheat brush.
Wheat cracker.
Wheat damper and dryer.
Wheat grader.
Wheat heater.
Wheat scourer.
Wheat separator.
Wheat steamer.
Wheel-cutting machine.
Wheel hoe.
Wheel jointer.
Wheel making machine.
Wheel molding machine.
Wheel press.
Wheel-turning lathe.
Wheelwright's machine.
Whitening machine.
Wig-wag.
Windlass.
Windmill.
Wine press.
Winnower.
Wire covering machine.
Wire cutting and forming m.
Wire forming machine.
Wire handle machine.
Wire mea., form. and cut. m.
Wire-rolling mill.
Wire-spring machine.
Wire straightening machine.
Wire testing machine.
Wiring press.
Wood bending machine
Wood facing machine.
Wood lathe.
Wood rasping machine.
Woodworker.
Wool burring machine.
Wool combing machine.
Wool oiler.
Wool scouring machine.
Wool washing machine.
Worm gear hoist.
Wringing machine.
Yarn flocking machine.
Yarn printing machine.
Yarn reel.
Yarn washing rollers.
Yarn winder.
Yucca grater.

Ma-chine' Bolt. A bolt with a thread, and a square or hexagonal head.

A machine *screw* is similar except as to the head, which has a slit for the insertion of the screw-driver.

Ma-chine' Gun. One in which the loading and firing are executed by mechanical means; the power being usually applied by means of a hand-crank.

The subject is considered under BATTERY GUN, *pp. 249–251, "*Mech. Dict.*," where the following are described or referred to: —

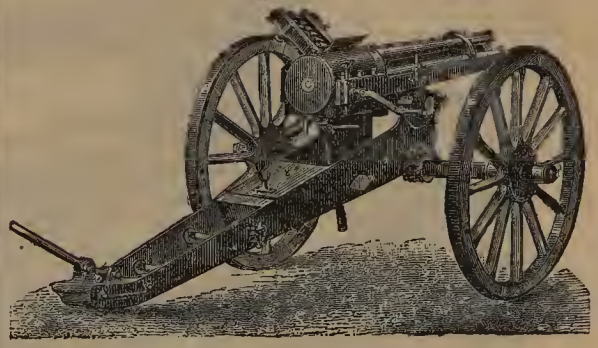
Hardy.	Townsend.	Natcher.
Dodge.	Fieschi.	Gatling.
Hedrick.	Requa.	French mitrailleur.
*Puckle.	Milburn.	Taylor.

See also MITRAILLEUR, *pp. 1454–1456, *Ibid.*, where are noticed those of —

*French army. *Taylor. *Abbertini. Hotchkiss.

B. B. Hotchkiss's revolving cannon consists of 5 steel barrels of 1.5″ caliber, grouped about a horizontal shaft, and

Fig. 1647.



Hotchkiss Cannon Revolver.

revolving in front of a breech-block, which has openings to receive the cartridge and empty shell. The gunner, by turning a crank extending from the stationary breech, causes the shaft and barrels to revolve, and, while this rotation is in progress, mechanism is operated which shoves fixed ammunition into the rear of each barrel, and then, as the loaded barrels continue their revolution, a spring plunger strikes each cartridge in succession, and each barrel is thus discharged in turn. The projectiles are percussion conical shells, weighing about one pound each, and the rapidity of fire has exceeded 100 shots per minute. As each shell on striking bursts into an average of 17 effective pieces, the above volley is equal to 1,700 bullets striking within an area of 260 square feet in the above period of time. The range far exceeds that of any small arm. The revolving cannon is made

by the inventor for the French government at St. Denis, near Paris, and is stated to be effective and accurate at 5,000 yards.

The *Gardner* machine gun (Fig. 1648) is mounted upon tripod or upon carriage; is automatic, transferring the car-

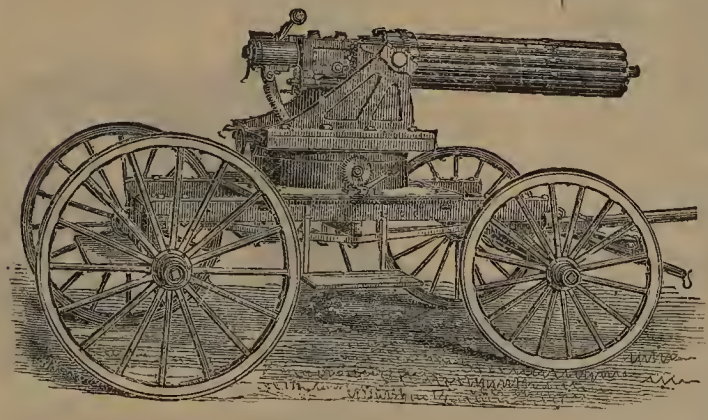
Fig. 1648.

Gardner Machine Gun.

tridge from the feed-port to the barrel, firing, extracting, and ejecting the empty shell, consecutively to each barrel. The barrels are stationary. The mechanisms for feeding and firing each barrel are independent; those for loading cartridges and ejecting shells are positive. The cartridges are fed automatically from a vertical magazine; the movements are derived from a hand-crank. The gun has traverse motion on its vertical axis in the stand, and adjustment for altitude by hinge and screw.

The *Taylor* machine gun has 12 barrels of 2″ caliber, each having a magazine capable of holding 12 cartridges. The

Fig. 1649.



Taylor Machine Gun.

magazines revolve, the loading is automatic, and the gun worked by one person by means of the lever on the tail-piece.

The *Bailey* gun has a circular cluster of parallel barrels, and is worked by a revolving crank, the cartridges descending in a case which is stuck into the hopper so as to feed automatically. It has one lock, made in two pieces, which works all of the barrels.

See also *Parkhurst's* machine gun. Patent No. 228,777.

Coloney's patents: 225,461. 225,466. 225,462. 231,652. 225,465. 231,653.

Farwell's machine gun consists of 10 steel barrels of .45″ caliber, arranged parallel to each other in a metallic frame. From center to center of the outer barrel is 3′. Each barrel is charged separately from a magazine containing 50 rounds of ammunition. The charging, firing, and extraction of exploded shells are all accomplished by the turning of one crank, at each revolution of which the whole 10 barrels are discharged, emptied, and reloaded. A system of cog-wheels connects the firing crank with an automatic traverse.

It differs from the Gatling gun in the simultaneous loading and firing of 10 barrels, the latter loading each barrel through the same magazine aperture and firing but one shot at a time, though with almost incredible swiftness.

The *Requa* battery has 25 barrels lying horizontal and parallel on a carriage. It is a breech-loader, and the barrels are fired simultaneously.

The arrangement of the barrels is similar to that of the "infernal machine" of Fieschi, with which he fired upon Louis Philippe and his staff, killing several persons, but missing the king. In Fieschi's device the barrels were separately loaded, laid on a bench, clamped, and a train of powder laid over the touch-holes.

In Requa's battery the paper cartridges are driven into all the barrels simultaneously by a sliding breech-block traversing at the rear of the whole platoon, and operated by a lever. Priming leads to each of the cartridges, and the charges are fired by a cap.

Two forms of the *Taylor* battery gun have the horizontal parallel (or converging) arrangement of barrels.

Lowell battery gun. "*Ordnance Report*," 1878, Appendix S, p. 375.

Hotchkiss, Revolving cannon, *Ibid.*, 1877, Appendix O, and p. 609 *et seq.*

Taylor, Battery gun, *Ibid.*, 1878, Appendix S, 1, p. 389, *et seq.*

Trial of *Hotchkiss'* revolving cannon, *Ibid.*, 1877, Appendix O.

Trial of *Hotchkiss'* revolving cannon, *Ibid.*, 1879, p. 143, with 17 plates.

Trial of *Gatling* gun, 5″ (English model), *Ibid.*, 1879, Appendix I^{12}, p. 190, with 15 plates. See

Gardner . . . . . "*Iron Age*," xx., Aug. 30, p. 11.
Hotchkiss . . . . . * "*Engineer*," xlii. 299.
Nordenfelt, Br. . . . * "*Engineer*," xlvii. 416.

See also REVOLVING CANNON.

Ma-chine' Twist. A kind of silk thread, made three-cord, and twisted from right to left. Made specially for use in the sewing machine. Sewing silk is two-cord, and twisted from left to right.

See account in *J. L. Hayes'* "*Centennial Report*," v. 96, 97.

Mack'in-tosh Steel. (*Metallurgy.*) Steel made from malleable iron by a stream of carbureted hydrogen directed upon the bath of metal in a furnace. C. Mackintosh patent, 1825. Also known as the Baron process.

Mack'e-rel Latch. (*Fishing.*) A cord-clamp which holds the inboard end of a mackerel line.

Mack'e-rel Plow. (*Fishing.*) Also known as a *fatting-knife*, for creasing the sides of lean mackerel to make them resemble No. 1.

Mag'a-zine' Bat'te-ry. (*Electricity.*) One in which a magazine contains the crystals which are supplied to the liquid as exhausted, to keep the liquid saturated: —

As in the *Daniells'* battery, which has a magazine of sulphate of copper crystals; and the *Anderson*, which has a magazine filled with bichromate of potassium crystals.

Anderson's battery, U. S. Patent, "*Scientific American*," * xliii. 115.

Mag'a-zine' Gun. A gun containing a supply of cartridges, mechanically furnished to the chamber of the barrel, seriatim.

The subject is considered on pp. 1367-1369, "*Mech. Dict.*," where the following systems are described or referred to: —

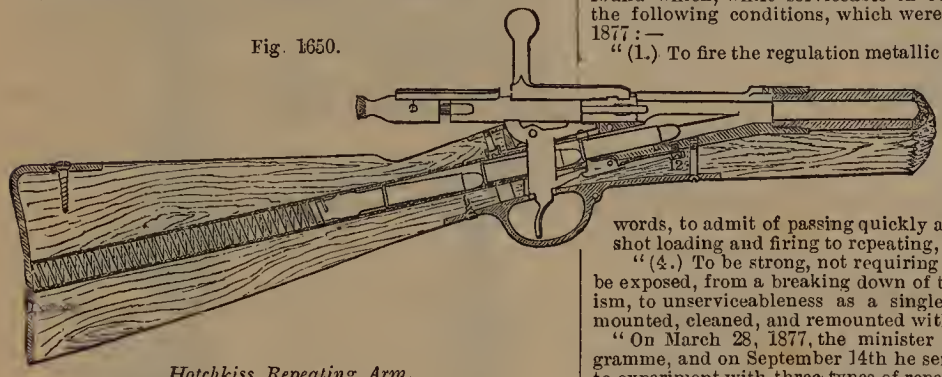
*Winchester. *Callen.
*Ward-Burton. Swiss.
Spencer. Meigs.

Also on pp. 853, 854, *Ibid.*, and Plate XVIII.

The Hotchkiss repeater is a bolt and needle magazine gun. The magazine in the butt contains six cartridges which are forced forward by a spring. The gun is shown in Fig. 1650.

The cartridges are inserted one at a time, to the number of five, pressing each backward into the chamber until a click

Fig. 1650.



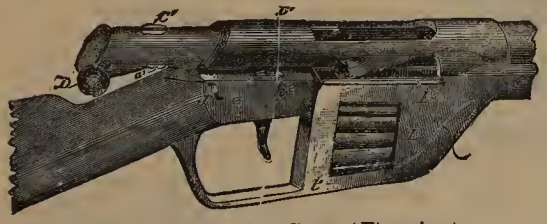
Hotchkiss Repeating Arm.

is heard, due to the head of the cartridge passing the cartridge stop. A sixth may be placed in the chamber. To load, turn the bolt and retract it. The bolt engages a cartridge, and the return motion forces the load into the chamber and cocks the piece. The piece has the usual 4 motions: Twist, draw, return, lock. The cocking being automatic, the piece is ready to fire.

Lieut. A. H. Russell's (U. S. Army) magazine gun is shown in Figs. 1651, 1652. The magazine is at the side and can be filled whether the piece be loaded or unloaded, the opening for insertion of the cartridge being accessible at all times.

The loading is on the bolt system, but no turning of the bolt is required. Fig. 1651 shows the bolt pushed forward

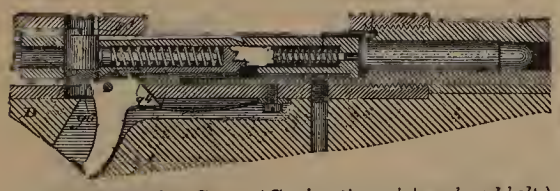
Fig. 1651.



Russell's Magazine Gun. (Elevation.)

slightly, forcing before it a cartridge just introduced into the receiver from the magazine *L*, which holds 5 or 6 cartridges, side by side. The magazine is at the side of the receiver and extends downward to the bottom of the trigger guard. The mouth of the magazine is at the side of the receiver, and the cartridges are forced upward by a spring so as to bring them in succession to the action of the bolt. A spring-gate pre-

Fig. 1652.



Russell's Magazine Gun. (Section through barrel and bolt.)

vents the escape of cartridges except to the receiver, while it allows them to be inserted sidewise into the magazine from without. They may be inserted singly, or the magazine may be filled quickly from a cartridge-box applied to the mouth of the magazine, the cartridges being forced in by the finger, the gate of the magazine yielding to the pressure from above and closing after the cartridges have entered.

The action of the bolt is rectilinear. It is drawn out by a handle which unlocks a pivoted catch-piece, *C*, to free the bolt, and relocks the piece *C* when the bolt is thrust home in loading. The forward motion of the bolt compresses the firing spring and the trigger catches in the hook of the firing pin. The breech mechanism is simple, and the operation requires merely a forward and back motion of the hand.

See also *Trabue's* magazine gun, pateuts Nos. 223,414; 223,660.

Report of trial of magazine arms for the French navy: —

"The French authorities have recently made a careful trial of repeating arms with a view to adoption should one be found which, while serviceable in other respects, fulfilled the following conditions, which were put forth in March, 1877: —

"(1.) To fire the regulation metallic cartridge of the army.

"(2.) To have the same trajectory and the same accuracy as the rifle model, 1874.

"(3.) So constructed as to be used as an ordinary single shot arm, or, in other words, to admit of passing quickly and simply from single shot loading and firing to repeating, and *vice versa*.

"(4.) To be strong, not requiring too tender care, not to be exposed, from a breaking down of the repeating mechanism, to unserviceableness as a single shooter; to be dismounted, cleaned, and remounted without difficulty.

"On March 28, 1877, the minister approved of this programme, and on September 14th he sent orders to Cherbourg to experiment with three types of repeaters, with detailed instructions as to the trials. These three arms were: —

"(1.) The *Hotchkiss*.

"(2.) The *Kropatschek*.

"(3.) The *Krag*.

"To these three the board confined themselves.

"The result of these trials showed that the magazine of the Hotchkiss was most quickly charged. The Hotchkiss also fires most rapidly; both in repeating and single shot fire the Kropatschek was not far behind it The Krag does not seem to have been well understood and manipulated by the men.

The Kropatschek — modified — with eight cartridges in its magazine beat the Hotchkiss which had only six, while the Krag with nine cartridges was best of all. The time necessary to discharge this latter arm's magazine of nine rounds was 24.85 seconds, in which time the Kropatschek had on an average fired 8.9 cartridges per arm, and the Hotchkiss 7.9 starting with the magazine closed; with the magazine open 25 seconds were occupied, in which time the Krag fired 9, the Kropatschek 9.3, and the Hotchkiss 8.25 rounds on an average. Single shot fire proved better than recharging the magazine and repeating continually. The minimum times taken to fire off the magazines, at the conclusion of the experiments, when the men were expert, were as follows: Hotchkiss, 6 rounds, in 10 seconds; Kropatschek, modified, 8 rounds, in 14 seconds; Krag, 9 rounds, in 17 seconds; giving an average time per round of 1.66, 1.75, and 1.88 seconds respectively.

"Finally, it was concluded that the Hotchkiss rifle is the easiest and quickest in charging the magazines; then the Kropatschek; and last, Krag. As to rapidity of fire, the Hotchkiss and Kropatschek are about equal. Large magazines have a great advantage; the magazine once empty, it is best not to attempt to refill it till leisure gives the opportunity." — "*Engineer*."

The following United States patents may be consulted: —

184,285 *Hotchkiss*, adopted by Springfield Board, U. S. Army.
213,538 *Wetmore*, Attachments to above.
189,848 } *Evans*, Gun.
207,350 }
201,855 } *White*, Magazine for charging revolver.
202,613 }
210,091 }
210,181 } *Burgess* Gun, As built by Martin.
213,866 }
221,079 *Livermore & Russell*, Impt. on Hotchkiss magazine.
221,328 *Lee* Gun, Recommended by Miles equipment board. Built at Sharp Works, Bridgeport, Conn.
230,823 *Russell's* magazine fire-arm (new bolt system.)

Appendix T to the "Report of the Chief of Ordnance," 1878, describes the official trials of magazine small arms for the United States service. It gives drawings and descriptions of the following magazine guns: —

No.	Name.	Plate.	Descriptive Page.
9.	Hotchkiss	I.	27
19.	Hotchkiss	II.	31 (adopted)
17.	Remington	III.	33
	Remington (modification)	IV.	
8.	Sharps	V	39
1.	Franklin	VI	40
2.	Ward-Burton	VII	42
11.	Burton	VIII	44
4.	Hunt	IX.	45
13.	Winchester	X.	46
22.	Burgess	XI.	49

List of Magazine Guns at trial (*continued*).

No.	Name.	Plate.	Descriptive Page.
21.	Ticsing	XII.	52
26.	Chaffee	XIII.	53
7.	Buffington	XIV.	54
15.	Miller	XV.	56
24.	Clemmons	XVI.	59
6.	Lewis-Rice	XVII.	58
14.	Lewis-Rice	XVIII.	60
	Russell, magazine for Hotchkiss gun	XIX.	63
	Guer, modification of Hotchkiss bolt.	XX.	

The tests were as follows: —

Preliminary test, for safety; fired by the exhibitor.

1. Rapidity with accuracy.
2. Rapidity at will.
3. Endurance, by continuous firing 500 rounds without cleaning.
4. Firing defective cartridges.
5. Exposure to dust and firing without cleaning.
6. Exposure to rust by sal-ammoniac and two days subsequently in the open air.
7. Excessive charges.

Supplementary tests of various kinds.

The following classification give the peculiar points of each relatively to the method of feeding the cartridge.

CLASSIFICATION OF MAGAZINE ARMS.

FOUNDED ON THE METHOD BY WHICH CARTRIDGES ARE FED FROM THE MAGAZINE.

- Magazine arms, supply chamber with cartridges from —
  - 1st, butt-stock
    - 1st, by a spring
      - 1st, direct: Hotchkiss; Lewis-Rice; Spencer.
      - 2d, indirect
        - 1st, by rotating barrel about axis parallel to it into line with magazine: Scott and Triplet.
        - 2d, to position opposite receiver: Clemmons.
    - 2d, by a rachet, which is —
      - 1st, automatic: Chaffee.
      - 2d, operated by hand: Springfield-Miller.
    - 3d, by a spiral cam (screw motion): Evans.
  - 2d, tip-stock, by a spring — on a carrier which is —
    - 1st, sliding at right angles to axis of bore: Winchester; Henry; Hunt; Vetterly.
    - 2d, rotating —
      - 1st, to position oblique to axis of bore: Burton; Ward-Burton; Sharps; Remington.
      - 2d, to position parallel with axis: Tiesing; Burgess.
    - 3d, sliding and rotating: Buffington.
  - 3d, magazine on top of barrel, by a spring — to position parallel to axis of bore and above receiver — and by gravity into line with axis of bore: Franklin.
  - 4th, magazine below bolt, by a spring (vertically) — to position opposite center of chamber: Lee.
  - 5th, revolving chambers: Hodges; Colt's repeating rifle; Revolving pistols.

FOUNDED ON THE MOTIONS OF THE PRINCIPAL PART BY WHICH THE BREECH IS OPENED AND CLOSED.

- Breech-loading small-arms have — fixed chambers closed by — movable breech-blocks which are
  - 1st, sliding. in line of axis of barrel by —
    - 1st, direct action, *i. e.*, bolt-guns having —
      - 1st, concealed locks: Hotchkiss; Remington; Burton; Ward-Burton; Franklin; Lee; Sharps Rifle Company.
      - 2d, center locks: Hunt.
    - 2d, indirect action, *i. e.*, moved by levers from — below: Winchester; Burgess; Tiesing.
  - 2d, sliding and rotating: Buffington; Chaffee.
  - 3d, rotating about an axis — at 90° to axis of barrel, and — horizontally lying —
    - 1st, above axis of barrel, and in — front: Springfield-Miller; Springfield-Clemmons.
    - 2d, below axis of barrel, and in — front, moved from — below (by a lever): Lewis-Rice.

The following detachable magazines, etc., are described in "*Ordnance Memoranda*," No. 15, Washington, 1873: those of —

Col. Benton's, Springfield,
R. T. Hare, Elliot.
Ira Merrill,

C. B. Norton's "*Appendix to American Inventions; Small Arms and Heavy Ordnance*," Osgood, Boston: 1882.

Mag-ne'si-a Light. A modification of the Drummond Light, in which a ball or crayon of carbonate of magnesia is substituted for chalk. See DRUMMOND LIGHT; LIME LIGHT, "*Mech. Dict.*"

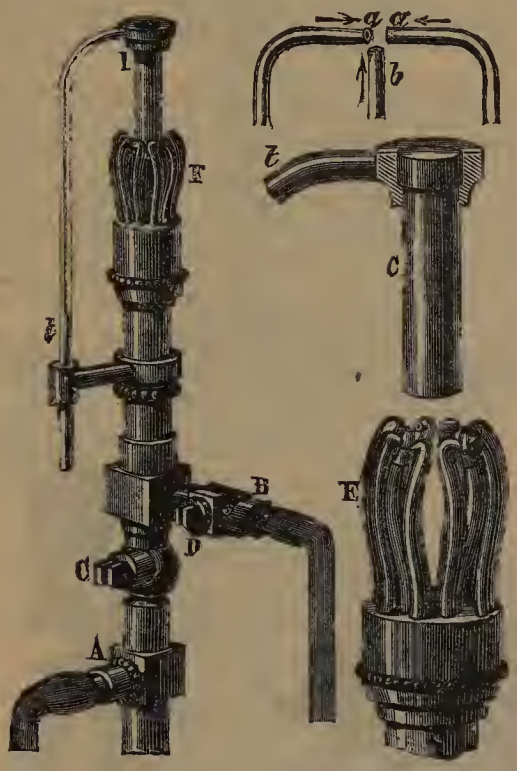
The *magnesia* light is not to be confounded with the *magnesium* light, in which latter the metal is burned, either in

strips or powder. See MAGNESIUM LAMP, p. 1370, "*Mech. Dict.*"

The substitution of magnesia for chalk is the invention of Sig. Carlevaris, an Italian physiciau.

In the apparatus of M. Tessié du Motay, as at first devised, a cylindrical crayon of compressed maguesia, prepared by

Fig. 1653.



Tessié du Motay's Magnesia Light.

the *système Caron*, was placed vertically above the burner, at which issues a melange of oxygen and ordinary illuminating gas. The design was afterwards modified, a change being made in the burner, so that the carbureted hydrogen arrived by two opposite pipes, *a a*, while the oxygen issued from the orifice of a vertical pipe, *b*, at a slightly lower level. Fig. 1653 shows the burner complete; on the right the respective oxygen and carbureted-hydrogen tubes, *A B*, with cock *C D* and the stem *t* of the holder *l*, from which the crayon *c* of magnesia is suspended, and by which it is vertically adjusted in the cluster of pipes *F*. On the right hand of the figure the *bec du Motay* is shown on an enlarged scale, and the arrangement of the pipes is also shown in a diagrammatic manner.

Mag-ne'si-um Light. A light made by burning the metal. See p. 1370, "*Mech. Dict.*," and Fig. 3684, p. 1689, *Ibid.*

Prof. Thurston's lamp is made by the American Magnesium Co. The strips of magnesium are rolled up on cylinders in the upper part of the apparatus. These strips are unrolled by clock-work in the lower part of the apparatus, and are carried between two small rollers, the uniform motion of which feeds them regularly into the lamp, where they are ignited. The ashes are cut off at intervals by means of eccentric cutters, and collect in the bottom of the apparatus. A small chimney is added, which is very important, as producing a draft of air directly through the flame. A portion of the products of combustion is thus carried away, and the flame becomes very intense, while it is less so without a draft. This lamp has been found very efficient, especially for marine signals. At trials made at sea, on two vessels stationed eight miles apart, the signals could be readily distinguished.

Larkin's lamp is based on a different principle. The magnesium is not employed as wire, or in strips, but as a powder. By this means the clock-work, or other mechanical device, has been dispensed with. The metallic powder is contained in a reservoir, which has a small opening in the bottom. The magnesium powder flows through this like the sand in a sand-clock. It is intimately mixed with a certain quantity of fine sand, in a manner diluted; first, in order to be able to make the opening sufficiently large; furthermore, to produce a continuous flow of the material. The mixture falls into a metallic tube, through which the illuminating gas is led from the upper end. The light is very brilliant, and the remaining sand falls into a vessel placed below, while the smoke passes away by a chimney.

Mag'net. See history and application, pages 1370–1374, "*Mech. Dict.*" See

Camacho	* "*Scientific American Sup.*," 19.
Prof. Henry's	* "*Scientific American*," xliii. 370.
Jamin, to make . . .	* "*Scientific Amer.*," xxxviii. 312.
Loan Collection, Br. . .	* "*Scientific American Sup.*," 520.
Spectrum	* "*Scientific American*," xxxiv. 244.
Needle in iron ore, Searching	"*Scientific American Sup.*," 753.

The chess board with magnetized pieces, for use in railway traveling, is a Prussian invention.

Mag-net'ic Bat'te-ry. (*Magnetism.*) A number of magnets joined together by their similar poles.

Mag-net'ic In-duc'tion. (*Electricity.*) The influence of a magnet through space, either to produce other magnets or to induce electric currents in metallic circuits.

Mag-net'ic Scale. A table or diagram exhibiting the para-magnetic and dia-magnetic metals in the order of their strengths respectively. The order given is from *Gordon's "Treatise on Electricity,"* London, 1880. The diagrammatic illustration, in two hypothetical curves tangential to a neutral line, is by G. H. Knight. The dia-magnetic curve requires, it may be added, great exaggeration to make it visible. *Gordon*, ii. pp. 15–17.

In para-magnetic bodies the magnetism is strong and polar. In dia-maguctic bodies the magnetism is weak and equatorial. For example, the polar magnetism of the strongest kuown para-magnetic snbstance (iron) is estimated to be forty thousand times that of the equatorial magnetism of the strougest dia-magnetic substance.

MAGNETIC SCALE.

Mag-net'ic Sep'a-ra'tor. An instrument or apparatus for separating iron from other matters: as iron filings from those of brass; scraps of nails or wire from wheat, etc.; iron particles from ore in powder.

To remove wire from wheat	* "*American Miller*," vii. 106.
	* "*Scientific American Sup.*," 2781.
	"*Scientific American*," xlii. 194.
"Eureka,"	* "*American Miller*," viii. 368.
Vavin, Fr.	"*Van Nostrand's Mag.*," xix. 21.

See also ORE SEPARATOR.

Mag-ne'to Call'-bell. The sounder of a telephone circuit. See Fig. 508, p. 155, *supra.*

Mag'ne-to-e-lec-tric'i-ty (*Electricity.*) Electricity produced by magnetic induction.

Mag'ne-to-e-lec'tric Ma-chine'. The modern accepted definition of this is about as follows: —

That class of devices for translating motion into electricity in which the magnetic field is formed by permanent magnets or electro magnets energized by a current of electricity independent of the current generated by the machine itself.

Under DYNAMO-ELECTRIC MACHINE, pp. 283–286, Figs. 890–905, and Plates XI., XII., the sub-

ject is considered. The distinction between *Dynamo-electric* and *Electro-magnetic* represents a real difference in action; but this differentiation of terms is comparatively recent. See definition of the DYNAMO-ELECTRIC MACHINE, p. 283, *supra*.

The Gramme & Ivernois and Pacinotti electro-magnetic machines are shown in Plate XI., opp. p. 283, *supra*.

Fig. 1654.

Portable Magneto-electric Machine.

Fig. 1654 is an illustration from the "*Practical Magazine*" of a powerful magneto-electric machine, built at the Siemens & Halske telegraph works in Berlin, and intended for a portable electric light apparatus for field, military, and exhibition purposes.

The machine is a locomotive magneto-electric induction engine, in other words, a very powerful electrical battery, mounted on a carriage, to which horses may be harnessed in order to transport it from place to place. The fore part of the vehicle is occupied by the magneto-electric apparatus, which is driven by a small vertical steam-engine located in the rear.

Currents of electricity are induced in coils of insulated wire wound upon a metal drum, by causing the latter to rotate rapidly around an iron core placed between powerful magnets. The electric current is conducted to any desired point, by means of insulated wires connected with the magnetic poles. When used for illuminating and signaling purposes, the conductors are led to an electric lamp, which is provided with a special arrangement for regulating the intensity of the current. The steam boiler is vertical, made of steel plate, with a fire-box suspended below; there are twin cylinders, which set in motion a couple of driving wheels, connected, by means of belting (omitted in the figure), with the drum of the induction apparatus.

The engine works up to 200 revolutions per minute, producing 450 revolutions per minute of the drum of the induction apparatus. The latter is of thin german-silver plate, covered with eight separate coils of copper wire of 0.28″ gage, and rotates between two very powerful horse-shoe magnets. At full speed, the current induced is sufficiently intense to heat a copper wire, 0.04″ in diameter and 38′ long, to redness, and, photometrically, is equal to 14,000 wax candles. The draft of the apparatus is about 2½ tons.

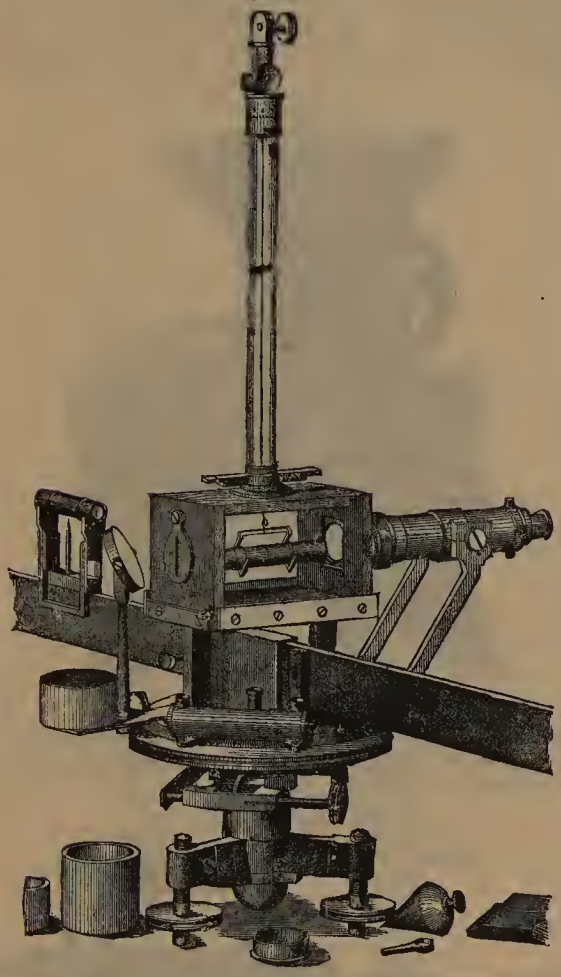
See *Barker* . . . . . * "*Scientific American*," xxxiv. 195.
Breguet, Fr. . . . . * "*Engineering*," xxii. 182.
* "*Scientific American Sup.*," 682.
Chutaux, Belgium . . " *Telegraphic Journal*," iv. 161.
de Méritens . . . . . * "*Telegraphic Journal*," vi. 393.
* "*Scientific American*," xxxix. 341.
Dubosq . . . . . * "*Manufact. & Builder*," x. 85.
Fitzgerald, Br. . . . * "*Engineer*," l. 284.
Gramme . . . . . * "*Engineering*," xxi. 147.
* "*Engineer*," xliv. 435, 461; xlvi. 329.
* "*Engineering*," xxvi. 65.
* "*Telegraphic Journal*," iv. 322.
Ladd . . . . . * "*Engineer*," xliv. 401.
* "*Manufact. & Builder*," x. 109.
Lontin . . . . . * "*Scientific Amer.*," xxxvii. 184.
Continuous current. * "*Telegraphic Journal*," iv. 100.
Niaudet . . . . . * "*Scientific American Sup.*," 129.
* "*Engineer*," xliv. 401.
* "*Manufact. & Builder*," x. 85.
Paris Exp. *Gramme* . . * "*Sc. Amer. Sup.*," 257, * 2237.
Portable, Engl. . . . * "*Scientific American*," xxxiv. 239.
Siemens . . . . . * "*Manufact. & Builder*," x. 108.
Siemens . . . . . * "*Engineer*," xliv. 401.
Soc. l'Alliance . . . . * "*Engineer*," xliv. 401.
Varley . . . . . * "*Telegraphic Journal*," vi. 160.
* "*Scientific American Sup.*," 1995.
"*Scientific American Sup.*," 521.

Mag′net-om′e-ter. The furnishing of a magnetic station includes instruments for dip or inclination, variation or declination, and intensity.

The subject of the discovery of the variations of the compass by the Chinese, and subsequently by Columbus; the detection of the dip, and the invention of the dipping needle by Norman, of London; the determination of the *agonic* lines, eastern and western; various voyages of observation for the determination of magnetic phenomena; and the world-wide system of magnetic observatories, are referred to on pp. 1873, 1874, "*Mech. Dict.*"

"There are two forms of unifilar magnetometers in use: those with a complete astronomical theodolite, or alt-azimuth, mounted to the magnetic north or south of the box in which the collimator-magnet is suspended, and on the *same* stand with it; and those which have the box with suspended magnet mounted centrally over, and firmly connected with an azimuth-circle, the reading-telescope being mounted eccentrically on supports. The first form (devised by *Gauss*) is the preferable one in field use; it admits of greater expedition, allows of greater ease in observing, and is almost indispensable when the astronomical meridian has to be determined. With the magnet to the south of the theodolite, it

Fig. 1655.



United States Coast Survey Magnetometer.

readily admits of observations of the sun, for the determination of time and azimuth (also of latitude, if required) without interfering with the magnetic work proper. Deflections are read off on the scale of the collimator magnet, and must be converted into angular measures. The second form (see Fig. 1655), by *Dr. Lamont*, is capable, perhaps, of greater accuracy, and is better suited for a fixed observatory, especially when declination disturbances also are to be observed, or at stations where there is a large daily range in the declination. The angles of deflection are at once read off. In order to observe the azimuth-mark, the magnet and box have temporarily to be removed, which is unnecessary in the first form of the instrument. When observing deflections, the bar, and consequently the deflecting magnet, remain fixed in the magnetic prime vertical, in the magnetometer, with attached theodolite; but in the second form of the instrument the deflecting and deflected magnets always remain at right angles to each other. Improvements have been made at the Coast Survey Office in the construction of magnetometers, with a special view of making them more portable than the older instruments, which were found unnecessarily large and heavy. A 3″ Casella theodolite was utilized for this purpose. The magnet (3″ long and ¼″ in diameter) and light box, with glass tube, were first attached to the upper frame of the theodolite; afterward to its stand, by which greater steadiness was secured. The relative horizontal intensity only could be measured by means of oscillations. Subsequently, a similar instrument was fitted up with 2 magnets, inertia ring, and deflecting bar for absolute measure, the magnets being only about 1¼″ and 1½″ in length. Several instruments were constructed with 4″ theodolites and magnets, 1.50 and 1.84″ in length, respectively; diameter, 0.3″. One of these instruments is presented in Fig. 1655. The upper part of the theodolite can be removed, and the magnet-box placed on its azimuth-circle."—*Prof. Hilgard.*

See: *Hopkins* . . . . * "*Scientific American*," xli. 99.
"*Manufact. & Builder*," xi. 222.
Mag. inclin. apparatus. * "*Scientific American Sup.*," 2551.

Mag'ne-to-print'ing Tel'e-graph. A printing telegraph actuated by magneto-electric machine. In that of *Anders*, the machine is driven by a treadle. See Fig. 3960, p. 1802, "*Mech. Dict.*"

Mag'ne-to-tel'e-phone Call. A small magneto-electric machine with bell attached, acting as a call signal for a telephone. Fig. 508, p. 155, *supra.*

Numerous examples, *Hopkins*, * "*Sc. Am. Sup.*," 2570, 2571.

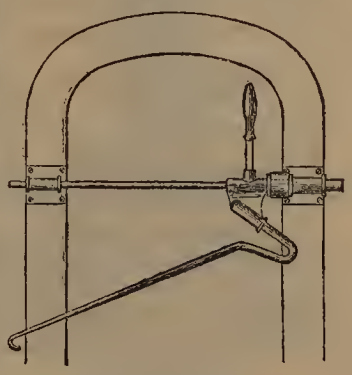
Mag'no-phone. A name applied by W. L. Scott, an English investigator, to what is now generally known as the *microphone.*

"*Manufacturer and Builder*" . . . . x. 151.
"*Engineer*" . . . . . xiv. 374, 408.

Maid'en Nut. The inner one of two nuts on the same screw: the outer is the *jam*-nut.

Mail Car. (*Railway.*) A postal-car. One for carrying mail bags; frequently fitted up for sorting letters *in transitu*, and for receiving and delivering bags *en route.* When thus fitted, such a car is specifically known as a *post-office car.*

Fig. 1656.



Mail Catcher.

Mail Catch'er. (*Railway.*) A device on a postal car to catch mail bags at a station without stopping the train.

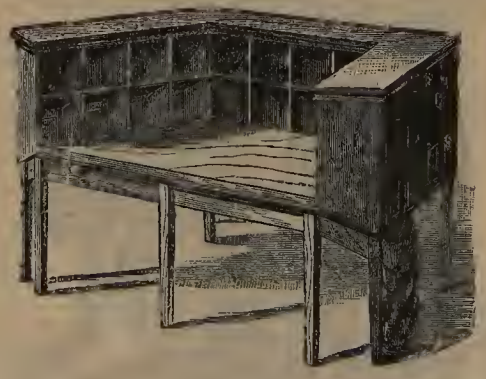
It usually consists of a bent iron bar on the car to catch into the loop handle of a mail bag, exposed on a platform post for that purpose.

French . . . . . "*Sc. Amer. Sup.*," 835.
Bag fastening, *Mertz & Worman* * "*Sc. American*," xli 310.

Mail'ing Ta'ble. A table at which mail matter is distributed to the mail bags for the various routes or stations.

On three sides of the table are tiers of boxes, each having a swinging door at the rear, and conveniences for fastening

Fig. 1657.



Mailing Table.

a bag at the rear of the box when the door is opened. Mail may be thrown into the box at any time, and the door opened when the bag is ready.

See also DISTRIBUTING TABLE, Fig. 835, p. 262, *supra.*

Main Keel. (*Nautical.*) As distinguished from the false keel, keelson, etc., which are adjuncts or appendages.

Main Spring Vise. A compressing tool for condensing the main spring of a gun-lock in order to put it in the lock. Fig. 1658.

Main-tain'ing Wheel. (*Horology.*) A wheel actuated by a spring, to keep a watch going while being wound. A *going* wheel.

Maize Cut'ter. A large form of chaff cutter. More especially one for cutting green corn for ensilaging.

See ENSILAGE CUTTER, Fig. 971, p. 315, *supra*.

Fig. 1658.

Main Spring Vise.

Ma-jol'i-ca. (*Ceramics.*) A species of fine pottery with opaque enamel and brilliant colors. The name is derived from Majorca. See p. 1376, "*Mech. Dict.*"

See also MEZZA MAJOLICA, a ware with a leaden glaze in which the colors run so as to give a softened or mezzo effect.

Mal'le-a-ble Bronze. A simple method of rendering bronze as malleable as copper or iron, has been announced by Dronier.

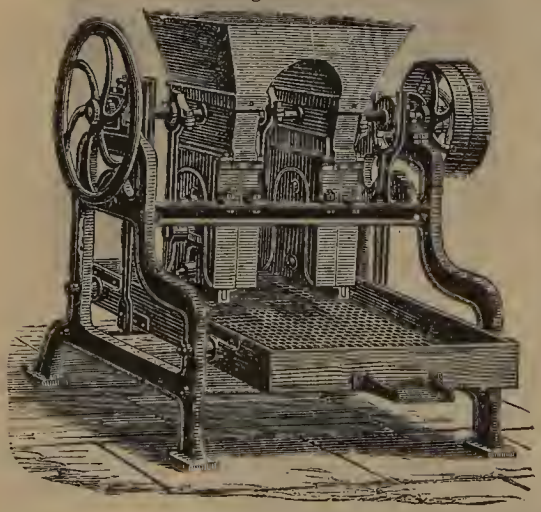
It consists in the addition of ½ to 2 per cent. of mercury. The mercury seems to act mechanically rather than chemically, and may be combined with one of the metals of which bronze is made, before they are combined, by pouring it into the melted metal and stirring well, or it may be put into the melted copper along with tin, or just after the latter has been added, or an amalgam of tin is stirred into the melted copper.

Mal'le-a-ble I'ron Pro'cess. (*Metallurgy.*) A process of decarburizing cast or pig iron by heating in an ordinary oxidizing atmosphere below the fusing temperature. It proceeds gradually from the surface to the center. Articles are packed in oxide of iron in boxes and exposed in ovens to a red heat for 5 or 6 days. See pp. 1376–1377, "*Mech. Dict.*"

Malt Clean'ing Ma-chine'. A machine of the nature of a grain cleaner, in which barley is freed from all extraneous matters, such as seeds of other grain, grass and weed seeds, dust and foul matters. This is a preliminary to malting.

See also Fig. 1256, Plate XX., opposite p. 416, *supra*, and other machines of the same group.

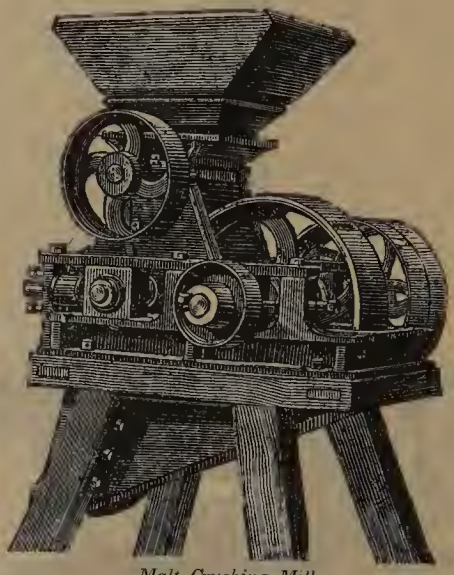
Fig. 1659.



Malt Cleaning Machine.

Malt Crush'ing Mill. A machine for grinding malt preliminary to mashing. Fig. 1660 is a French machine, by Duprez, of Rheims, which has an ingenious mechanical arrangement to throw out stones and nails. By the rapid motion of the machine the fecula of the malt is completely divested

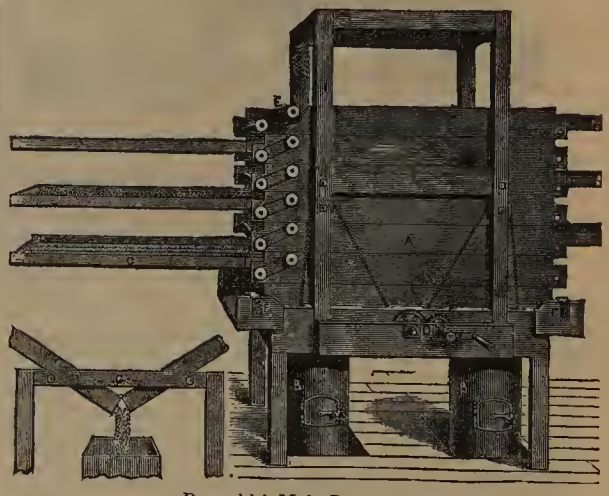
Fig. 1660.



Malt Crushing Mill.

of its natural envelope, which secures complete maceration and perfect infiltration in the vat during the mashing process.

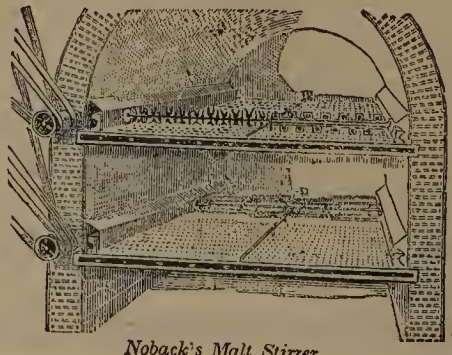
Fig. 1661.



Reynolds' Malt Dryer.

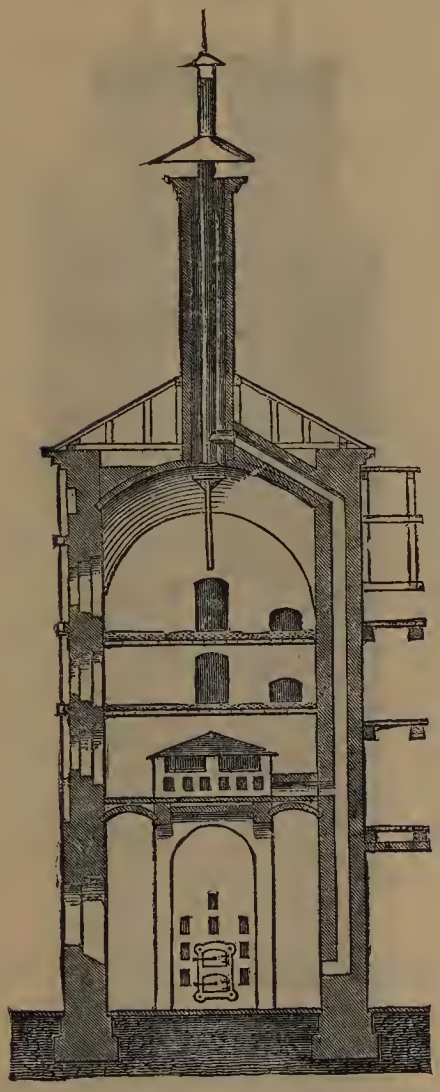
Malt Dry'er. A machine or apparatus in which malt is artificially dried in order to arrest the pro-

Fig. 1662.



Noback's Malt Stirrer.

Fig. 1663.



Malt Dryer. Noback Frères.

cess of germination and the chemical change in the constituents of the grain.

The malt-kiln is the older form of apparatus and exposure in the *oast* succeeded the previous operations of steeping, couching, and flooring. See Fig. 3036, p. 1380, "*Mech. Dict.*"

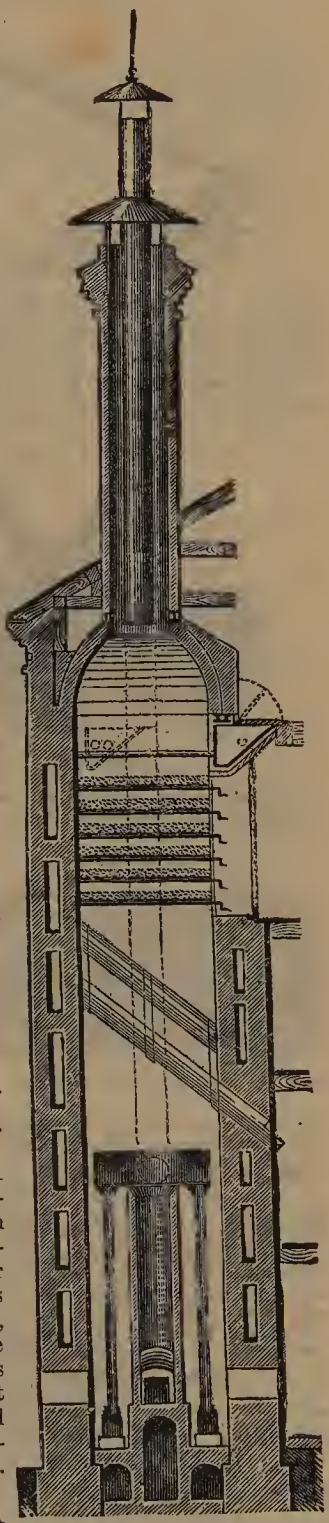
Reynolds' machine, Fig. 1661, has a vertical series of wire-bottom trays on which the malt is spread, and furnaces beneath, which send a heated current of air upward through the chamber in which the trays are placed.

A is a sectional chamber, with three compartments; each section contains rollers on which the trays *C* move backwards and forwards through the hot and cold air alternately as desired, the center being only partially heated by the two heaters *B B*; *C* are folding trays, twice the length of the chambers; *D* crank and gear wheels attached to movable frame *F* by chains, which serve to raise the entire sectional chamber and trays 10″, to admit a fresh tray when desired. Below is shown a table with rollers, showing the manuer of discharging the malt from the trays when finished.

The malt kiln of Brüder Noback and Fritz, Prague, Bohemia, is shown in Figs. 1662, 1663, 1664. Fig. 1662 shows two floors in the upper section of the tower, Fig. 1664.

The malt is spread evenly on the floor, the latter being made of slats, of wires or wire cloth, so as to allow of the passage upward of the heated air from the stove shown at the lower apartment of the tower. Some differences of arrangement of the heating apparatus in the towers will be noticed in the Figs. 1663 and 1664 respectively. Each has a stove in the lower story, a flue which has a rectangular deviation to a flue built in the wall and a return to the chimney which crowns the whole. The heat generated by the stove suffuses the chamber and passes upwardly through the perforated floors, and the layers of malt, and escapes by the anuular space arouud the central smoke flue in the chimney. Iu oue of the figures, two malt floors are shown, and in the other as many as six. Each has the traveling stirrer, shown more in detail in Fig. 1662. This is a shaft which is armed with paddles and extends across the width of the malt chamber and has at the same time a movement of translatiou lengthwise of the chamber; so that it moves *along* the floor, stirring up the malt the whole *width* of the floor. The two movements are by gearing and rack iu the covered side chambers which run lengthwise of the floor. When the stirrer has reached the end of its course, the belt is automatically shifted and the return course commences. See MALT TURNER, Fig. 1666, *infra*.

Fig. 1664.



Malt Tower. (*Noback, Prague.*)

Malt Ma-chine'.

See cleaner, Aust., Fig. 1
* "*Sc. Amer. Sup.*," 4076.
Duprez, Fig. 1, Fr.
* "*Engineer*," 1. 266.
* "*Sc. Amer. Sup.*," 1795.
Crusher, Austrian, Fig. 2.
* "*Sc. Amer. Sup.*," 4076.
Neubecker, Fig. 2, Ger.
* "*Engineer*," 1. 266.
Damper, Austrian, Fig. 3.
* "*Sc. Amer. Sup.*," 4076.
Neubecker, Fig. 3, Ger.
* "*Engineer*," 1. 266.
Kiln, Fig. 44, Austria.
* "*Engineer*," 1. 458.
Screen, *Nalder*, Br.
* "*Engineer'g*," xxvi. 479.
* "*Engineer*," xlvi. 443.

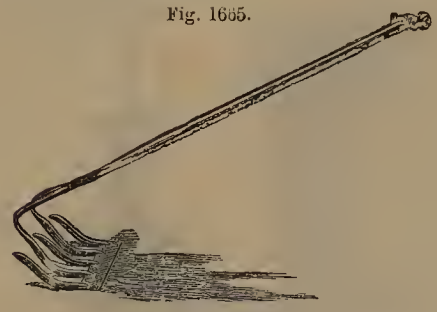
Malt Rake. A hand tool used in stirring malt on the kiln floor. The hoe portion scrapes the floor and allows no grains to escape being raised, and the fingers at the rear allow the grains to escape as the object is simply to stir and not to give a movement of translation. (Fig. 1665.)

Malt Screen. A device for cleaning extraneous matters from barley or from malt. See Fig. 1248, Plate XX., opp. page 416, *supra*.

Malt Turn'er. A mechanical arrangement for turning the malt while being heated in the kiln. (Fig. 1666.)

The floor of the kiln is made of wire, and the turning apparatus consists of a shaft having four arms projecting radially from it, on the ends of which are wire brushes clamped between two scrapers. This shaft has two motions, one rotating and the other longitudinal. When it arrives at

Fig. 1665.

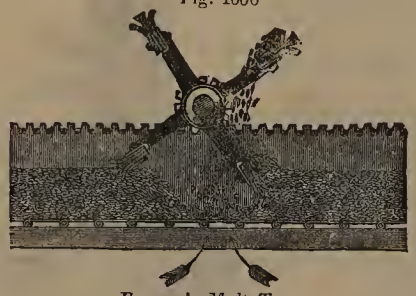


Malt Rake.

the end of the floor it shifts the driving belt, and returns over the same course.

Malt'wood's Find'er. (*Microscopy.*) A means for registering the position of an object on a slide.

Fig. 1666



Bergner's Malt Turner.

It is a slide with numbered rulings, 100 × 100. A slide containing an object of considerable area, and a point of special interest in the field being observed, the slide is removed and the finder substituted; the exact square is noted, and this being marked upon the slide of the object, the particular point of interest in the field of the slide can be at once brought into view, by placing the finder on the stand and bringing the number square into the field, and then substituting the slide with the object.

Fig. 1667.

Maltwood's Finder.

Man En'gine. An apparatus for raising and lowering men in mines. Two forms are shown in Fig. 3042, p. 1382, "*Mech. Dict.*"

A more elaborate and capacious apparatus is used in the collieries of the *Sociétés des Charbonnages de Mariemont et Bascoup*. These large corporations own an area of some 500 square miles of coal fields, and employ 9,000 men, producing, from 14 mines, 7,000 tons per day. The apparatus for lowering and elevating the miners to and from their work is shown in Fig. 1668. *A* and *B* are two steam cylinders, connected by the pipe *C*, and containing water in the spaces below the pistons. The latter are attached to platforms *D* and *E*. A miner about to descend will step upon upper platform, *E*, when it is at the top. Steam admitted above the piston in cylinder *A* will drive the piston down the length of one stroke, and bring it even with a platform, *D*. Steam is then admitted above the piston in cylinder *B*, forcing said piston down, and hence driving the water into the other cylinder. This of course lowers *D* and raises platform *E*, and, as is evident, again brings two platforms on a level, when the piston in *A* is at its highest, and that in *B* at its lowest point. The miner now steps from platform *D* to a lower platform, *E*. Steam is again admitted, this time above the pistou in *A*; platform *E* sinks, and eventually comes on a level with a third platform, *D*, and so on. This operation is continued, the workmen entering at the top and stepping from one platform to another until the bottom is reached. The ascent is by the inverse method.

Ma-neu'ver-ing Wheel. One of the wheels on the top carriage of a gun, on which it runs in and out of battery on the chassis.

Fig. 1668.

Man Engine.

Man'ga-nese' Bat'te-ry. A galvanic battery using the peroxide of manganese. See LECLANCHÉ BATTERY.

Man'ga-nese' Bronze. An alloy made by P. M. Parsons, England, in 1877, by adding from 1 to 2 per cent. of manganese to the proper proportions of copper and zinc, as used in making brass.

The average tensile strength of the metal when forged or rolled is 30 tons per square inch, with an elastic limit of from 11 to 18 tons, and an elongation of from 20 to 45 per cent. when in the annealed state. When cold-worked, the breaking strength in bars or plates rises to 40 tons per square inch, with an elastic limit of over 30 tons, and an elongation of about 12 per cent. When drawn into wire, the strength goes up to 70 tons per square inch.

The effects of forging are remarkable, raising the strength to such high limits, and practically giving a new and most valuable metal to the world. In some respects, indeed, it resembles aluminium bronze, but is superior in resistance to this alloy, which does not exceed 22.6 tons, and is also inferior in elongation and elasticity. Manganese bronze will find an application wherever gun-metal is used, while the facility and benefit of forging will render it still more useful in construction.

It is already much used in armor and sheathing for vessels, the making of torpedo boats and launches, bearings, pins, brasses and piston rings of steam engines.

It is said to be 60 per cent. stronger than gun-metal, and wears 3 or 4 times as long.

Parsons' manganese bronze: trials at the government gun factories, Woolwich, Eng., in comparison with Muntz-metal and gun-metal, gave the following. "*Engineering.*"

Material.	Strain per sq. inch.		Ultimate elongation 2″.
	Elastic Limit.	Breaking Strength.	
	tons.	*tons.*	*per cent.*
Mang. bronze, cold rolled	34.4	39.6	11.6
Forged and annealed .	16.6	30.7	20.7
Hot rolled and annealed	15.2	27.4	12.8 *
Cold rolled and annealed	14.5	29.1	18.3
Hot rolled (mild quality)	11.0	29.0	45.6
Muntz metal, rolled and annealed	7.8	24.0	54.6
Gun-metal. Cast. . . .	7.0	16.0	16.6

* Broken, owing to a fault in turning.

In carrying out the invention, the copper should be first melted in a crucible or other vessel in the ordinary manner, and the spiegeleisen or ferro-manganese, either with or without the addition of wrought-iron scrap as sometimes practiced, should at the same time be melted in a separate smaller furnace capable of generating a high temperature in a graphite crucible under powdered charcoal, and when it is completely fused, and the copper is also fused, and at a boiling heat, the ferro-manganese should be poured into the copper and the two well mixed together by stirring with an iron rod previously made red-hot; the tin, or zinc, or both, should then be added in the usual way and in the requisite proportions, according to the kind of alloy it is desired to produce. After the tin and zinc are added the metal should be again well stirred with a red-hot rod and skimmed; it may then be either poured into ingot molds for future use, or it can at once be cast in molds to produce any articles required.

Four kinds of manganese bronze are at present manufactured, varying somewhat in their qualities: —

1. For forging and rolling into plates, sheets, and drawing into wires and tubes.
2. For casting into bars and plates subjected to strain.
3. For casting into bearings and brasses.
4. For casting into valves, faces, piston rings, slide blocks, top and end connecting rod brasses, etc.

The following U. S. Patents may be consulted: —

203,266 *Hale*, May 7, 1878.
206,604 *Parsons*, July 30, 1878.
178,490 *Ward*, June 6, 1876.

Prof. Genti publishes an analysis or a specimen of manganese bronze from a Transylvania factory. It is nearly of the color of brass, is tenacious and ductile under the hammer, and contains sulphur, manganese, copper, zinc, iron, with traces of silica, tin, and carbon. The essential ingredients are 15 parts of copper, 4 of manganese, and 1 of zinc. — "*Revue Indust.*"

See also MANGANESE COPPER, which is also known as CUPRO-MANGANESE.

The subject may be pursued by reference to the following: —

"*Scientific American*" . . xxxiv. 356; xxxv. 259; * xxxvii. 345; xli. 21.
"*Scientific American Sup.*," 489, 807, 226, 1635, 2440, 2971, 3345.
"*Iron Age*" . . . . . xvii., March 30, p. 3; May 4, p. 1; March 16, p. 3; May 6, p. 17. xviii. Nov. 2, p. 7; xxi, June 13, p. 15; xxiv., July 10, p. 11; Sept. 18, p. 1; xxv., May 20, p. 24.
"*Manufacturer & Builder*" viii. 104; x. 24; xii. 111.
"*Van Nostrand's Mag.*" . xiv. 541; xviii. 287.
"*Eng. & Mining Journal*. xxi. 277, 306; (U. S. Patent, 206,-604, July 30, 1878); xxiv. 441; xxviii. 55, 360; xxix. 221; xxx. 54.
"*Engineering*" . . . . xxi. 152; xxvii. 523; xxii. 280; xxiv. 330.
"*Min. & Scientific Press*" . xxxii. 195; xxxvii. 3; xxxviii. 347.
"*Am. Man. & Iron World*" xxv., July 25, p. 8; xxvi., Jan. 16, p. 7; xxvi., Feb. 13, p. 8.
"*Engineer*" . . . . . xl. 123; xlii. 274; xliv. 301.
"*Telegraphic Journal*" . Copper, 15. Manganese, 4 Zinc, 1 } vi. 86.
"*English Mechanic*" . . xxvii. 475.
"*Technologiste*" . . . . xxxvii. 168; xli. 489.

Man'ga-nese' Cop'per. An alloy made at Isabellenhuette, near Dillenburg, Germany.

Copper	70
Manganese	30
	100

It is used as an addition to brass, bronze, etc., for increasing the density, tensile strength, and ductility of the metal, as the formation of oxides of tin or copper, which impair the physical properties of the material, is prevented by the great ease with which manganese is oxidized.

For bearings the following is recommended: —

Copper	80
Manganese copper	9
Tin	6
Zinc	5
	100

Larger amounts of manganese — for instance, 2.3 to 6 per cent. — make the metal particularly hard, and it is stated that bronze can be made in this manner to assume a hardness approximating that of steel.

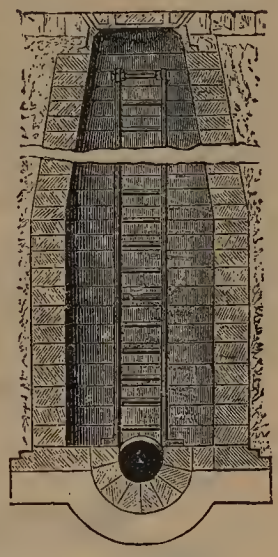
Man Hole. An opening by which a city subway or sewer is reached from the street.

Fig. 1669.

The sub-ways of London and Paris are spacious and far-exteuding. See Fig. 6040, p. 2462, "*Mech. Dict.*"

The man-hole and manhole cover in Figs. 1669, 1670 are those used in London, carefully built in masonry, with standing iron ladders and with elm blocks in the cover rim, or an iron plate, in the respective figures.

Batten, Br., *"*Engineer*," l. 343.



London Man Hole.

Man'i-fold. 1. (*Heating.*) The chambers with nozzles into and from which the pipes of a radiator lead. Fig. 1671 shows two manifolds, a set of bent tubes with couplings, and a pair of coil plates to hold up the system.

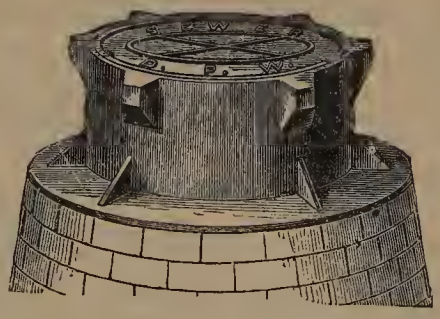
Manifolds are: back outlet, side outlet, double, etc.

2. A method of multiplying copies of a writing.

Man'i-fold Writer.

One French manifold writer consists of a metallic *slate* covered with tallow, mixed with one of the purple or red coal-tar colors. A sheet of tissue paper is laid thereon and writ-

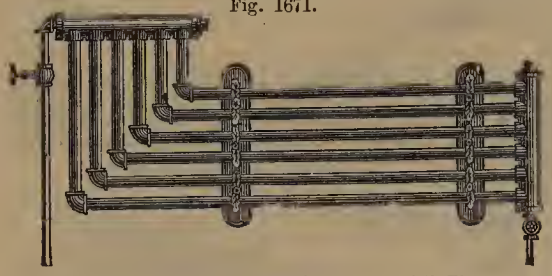
Fig. 1670.



Stone's Man-hole Cover. (*London.*)

ten on with a hard pen without ink. On taking up the tissue paper the writing reversed is found upon the other side. The tissue paper is now laid (inky side up) on several folds of wetted blotting paper; the writing paper intended for the reception of the impression is moistened (sponged over) with an aqueous solution of gum tragacanth, laid upon the

Fig. 1671.



Radiator for Wall, with Manifolds and Coil Plates.

matrix, and placed for a few seconds in a copying press. By these means 20 or 30 good copies can be obtained.

Another method has sheets of varnished paper to write on, with an ink by which the varnish is destroyed and the paper rendered porous. This is then placed on an ink pad, and the writing paper to be employed upon the top. On squeezing, ink is forced through that portion of the paper from which the varnish has been dissolved, and an impression is produced. An indefinite number may be so obtained.

E. De Zuccato's facsimile process for multiplying MSS. by chemical means is as follows: —

A sheet of thin paper is first prepared with a resinous varnish and dried. Upon one side of this the writing is executed with an ink consisting of a colored solution of potash or soda. The soluble compound formed by the alkali and resin is next removed by water, leaving the paper pervious to fluids where the ink lay upon it. This sheet is now placed face down upon a pad damped with a solution of persulphate of iron, and upon its back or upper side is laid the sheet to be printed upon, stamped with a dilute solution of ferrocyanide of potassium. After the pressure of a copying press has been applied, the facsimile writing will be found in blue (Prussian blue) upon the blank sheet. By substituting other sheets similarly prepared a large number of copies may be obtained from the same matrix.

Man'i-graph. A name for a method of multiplying copies of writing.

See COPYING PROCESS; GELATINE COPYING PROCESS; HECTOGRAPH, etc.

Ma-nip'u-la'tor. 1. An intermediate contrivance for handling plates without exposing the hands to injury. Useful in working with photo-

Fig. 1672.

Negative Manipulator.

graphic plates and negatives. At the end of the handle is a suction disk of caoutchouc.

2. A machine for shampooing or pummeling the body; rubbing the arm, legs, back, kneading the abdomen, etc. A substitute for exercise with the bed-ridden; and a useful adjunct in gymnastic training. See EXERCISING MACHINE.

Ma-nom'e-ter. An instrument for measuring the elastic force of a gas or of steam. See Fig. 4039, and references to Boyle and Ramsden, page 1684, "*Mech. Dict.*,"

Koenig's flame manometer	Figs. 1046, 1047, page 344, *supra*.
Hopkins, flame manometer	* "*Scientific American*," xxxix. 135.
Electric	"*Scientific American*," xxxix. 74.

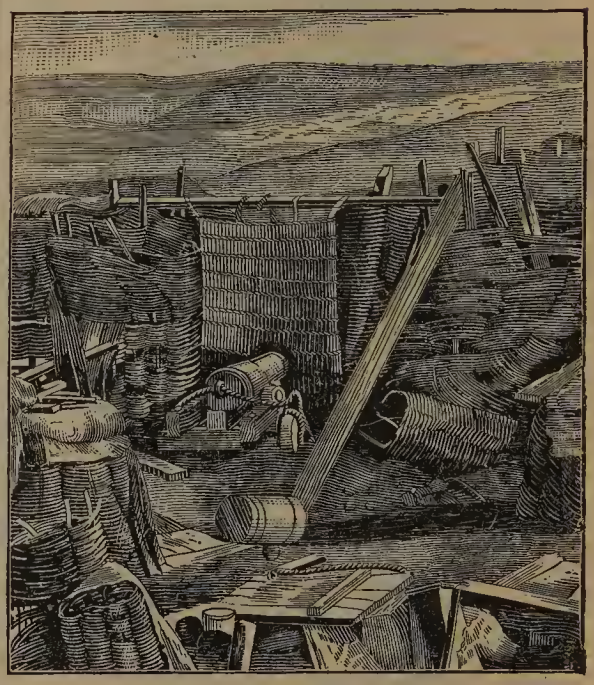
* *Breguet's*, *Vidi's*, *Galy-Cazalat's*, Article "*Manomètre*," *Laboulaye's* "*Dict. des Arts et Manufactures*," iv., ed. 1877.
* *Bourdon's*, *Ibid.*, "*Manomètre*," ii., Figs. 4, 5.
* *Journeux's*, *Ibid.*, "*Manomètre*," ii., Figs. 1, 2, 3.
* *Richard's*, *Ibid.*, "*Manomètre*," ii., Figs. 6, 7.
See also, *Ibid.*, "*Éclairage au Gaz*," ii., Fig. 96 *et seq.*

Mariotte's tube, *Deschanel's* "*Natural Philosophy*," Am ed., Part I., p. 171; *Depret's* apparatus for proving Boyle's law; *Regnault's*, for the same, and *Pouillet's*, for showing unequal expansion of different gases, are also shown on pp. 172-174 of same work.

Man-te'an. (*Fabric.*) A fine French worsted stuff made of carded wool, both warp and weft; taffetas armure, which see.

Man'te-let. A bullet-proof screen to protect gunners serving a piece from the fire of the enemy. It is usually woven of rope. Fig. 1673 shows a mantelet in an embrasure of the Malakoff tower, before Sebastopol, in the Crimea.

Fig. 1673.



Mantelet, in the Malakoff Battery.

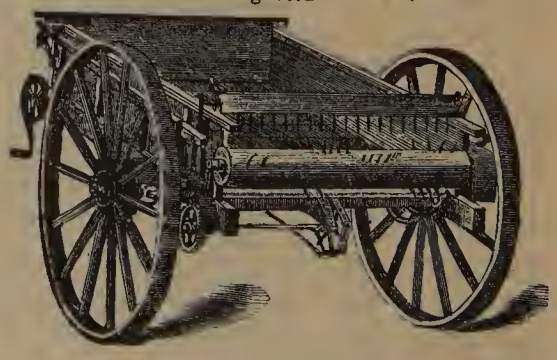
Mantelets are also used in front of rifle-pits; also to protect pioneers and sappers, and those working or passing in the trenches and approaches of an invested work.

Ma-nure' Drag. (*Add.*) 2. A fork with bent tines to unload manure by dragging it off the wagon.

Ma-nure' Spread'er. A cart having a bed of traveling slats, and a spiked roller at the tail gate, to distribute the load while the vehicle is moving over the surface of the ground.

It can be attached to the fore-wheels of any ordinary farm wagon. The floor of the cart is a revolving apron, which is

Fig. 1674.



Kemp Manure Spreader.

carried backward by the gearing, bringing its contents against a rapidly revolving beater, which breaks up and distributes the manure. It is thrown into gear by a single lever at the left hand of the driver's seat, and throws itself out of gear when the load is spent. In running to and from the field none of its machinery is in motion, and it may be used through the season the same as an ordinary cart.

Man'y-light Reg'u-la'tor. (*Electricity.*) An order of regulator for voltaic-arc lights which allows a number of lights on one circuit. Sce POLYPHOTE REGULATOR.

Mar'ble, Im'i-ta'tion. See recipes, p. 1390, "*Mech. Dict.*"

Statuary: Coat a plaster-of-Paris or papier maché figure with white dammar varnish and dust with pulverized glass; it then resembles *alabaster*. It may be varnished a second time and dusted with coarsely pulverized glass or mica and it will resemble *Carrara marble*. May be veined with a delicate blue pigment betweeu the coats.

To give to sandstone the appearance of marble: Impregnate the well dried stone with soluble silica and alumiua. For colors, add mineral pigments to the liquid.

Marbleizing limestone: Work the stone to form and theu put it in a boiler, submerged in water and bring a steam pressure of 75 to 100 lbs., according to the size of the object. Allow the object to cool; remove the object aud submerge it in an alum bath, colored or otherwise. — *Hosmer.*

Artificial, "*Building News*" "*Van Nost. Mag.*," xix. 324.
Imitation . . . . . "*Manuf. and Builder*," x. 12.
"*Scientific Amer.*," xxxv. 130.
Cement . . . . . "*Scientific Amer. Sup.*," 1457.
Sawing machine, Carrara, It. "*Min. & Sc. Press*," xxxvi. 211.
Working machine . . . . "*Scientific American*," xlii. 50.

Report on marbles, foreign and native, by *J. S. Newberry*, "*Centennial Reports*," vol. iii., Group I., p. 137, *et seq.*

Mar'ble-ized Glass. (*Glass.*) Made by immersing hot glass in water, reheating and expanding by blowing. The incipient fractures become joined but show in the article like veins in marble.

Mar'ble-iz-ing I'ron. First coat with a thin layer of plaster-of-paris and alum, made to adhere by previously roughening and oxidizing the iron. This coat being well leveled and ground smooth, the paint used will readily adhere.

Mar'bling Pa'per. Described on p. 1391, "*Mech. Dict.*"

Elaborate description and directions from "*Paper World*," reproduced in "*Manufacturer and Industrial Gazette*," iv. 2, pp. 6, 7.
Woolnough . . . "*Scientific American Sup.*," 1889.

Marc. The residuum of grapes after pressure therefrom of the *must*. Corresponds with the *pomace* of apples, the *grains* of malt.

Ma'rie-Da'vy Bat'te-ry. (*Electricity.*) One in which the zinc stands in pure water and the carbon in a paste of moistened proto-sulphate of mercury in a porous cup. See MERCURY BATTERY.

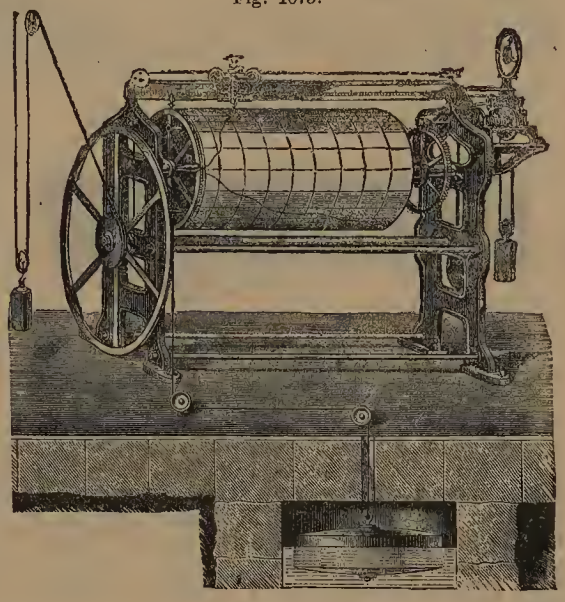
Sabine, London, 1867 229
Niaudet, American translation . . . . . * 140

Ma'ri-graph. A registering tide gage; by an extension of the meaning it may be held to mean an instrument for registering the fluctuations of height in sea, harbor, river, or canal. Other terms are used for some of these: such as *fluviograph*, etc. See also, TIDE GAGE, Fig. 6426, p. 2566, "*Mech. Dict.*"

The French Marigraph shown in Fig. 1675 is operated by an endless cord which connects with a float located in a suitable reservoir, into which the sea water enters. The changes of level of the water are registered on a large horizontal cylinder which is rotated by clock mechanism once in 24 hours. The cylinder is covered with a sheet of paper, changed fortnightly or monthly, and which is divided into longitudinal divisions, giving, on a reduced scale, the heights of the tides in meters and centimeters. A carriage, mounted on rollers upon a steel rule above the cylinder, carries a pencil which is pressed against the paper by a spring. The carriage communicates by an endless cord with a small grooved wheel mounted on the shaft of the larger wheel which receives the motion of the float previously referred to.

On a third wheel, of medium diameter, is wound a cord, which is drawn by a weight in an opposite direction to that of the cord of the float. When, therefore, the float rises, the effect of the weight is to remove the shaft so as to take up the slack of the cord so that the latter is always kept taut. The pencil carriage is similarly actuated, and traces on the cylinder a mark of which the extremity is the maximum height of the water. If the level is constant, the carriage remains motionless, and the pencil traces on the cylinder a line parallel to the transverse divisions.

Fig. 1675.



Marigraph

A dial placed above the mechanism shows the hour, and at the same time serves to regulate the changing of the paper, and to indicate the moment at which the apparatus should be started on its daily motion. An electric indicator serves to give warning of any desired level being reached by the water. The indicator is movable, and is set on a special rod on the rule at the point corresponding to the height of water to be noted. When the carriage, on reaching that point, comes in contact with the indicator, the effect is to sound a bell.

Ma-rim'ba. A musical instrument of percussion, consisting of bars which yield various tones when struck. A *sticcado* (from the Italian).

The instruments are frequently called by names which indicate the material of which the bars consist.

Marimba is Portuguese, and the instruments of Angola have been introduced into European museums under that name. The instrument is common over a large part of the African Continent, and also in Malaysia. It is found in Guatemala but is probably of negro introduction. One from Central America is in the National Museum, Washington, D. C.

See author's article on "*Crude and Curious Inventions at the Centennial*," 1876, '*Atlantic Monthly*," * vol. xxxix., pp. 523–525, where may be found the marimbas of Angola, Central Africa, of Malaysia (*gambang*) and Siam (*Ra-naht-ake*).

The subject may be pursued by reference to DULCIMER; HARMONICA; LAPIDEON; * WOOD-HARMONICON; XYLOPHONE; "*Mech. Dict.*" Also, STEEL-BAR PIANO, * Fig. 3689, p. 1695, *Ibid.* Also, * LYRE; METALLOPHONE, *supra et infra.*

All the above have bars in series arranged according to a musical scale. The scales vary; diatonic, pentatonic, and those of the African and Asiatic, not quite in harmony with either.

See also, MARAMBA, p. 1389, "*Mech. Dict.*"

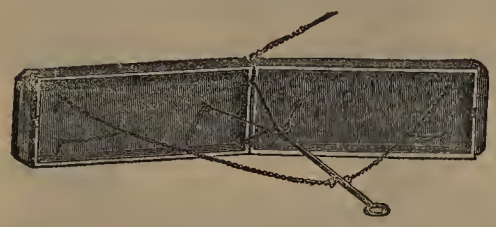
Ma-rine' Bat'te-ry. (*Electricity.*) One in which the plates are immersed in the sea, to be acted upon by the salt water.

Ma-rine' Boil'er. See under the following references: —

SS. "Arizona," Br. . . * "*Engineering*," xxx. 192.
High pressure, *Boyer*, Br. * "*Engineering*," xxvii. 410.
Water tube, British Navy . . . . . * "*Engineering*," xxi. 318, 349.
Furnaces, tug "Grinder," Br. . . . . * "*Engineer*," xlv. 23.
Herreshoff . . . . . * "*Engineer*," xlvii. 259.
And engines. "Hohenzollern," Ger. Navy . * "*Engineering*," xxiii. 308, 314.
Passman, Br. . . . . * "*Engineer*," xlvi. 358.
High pressure, light weight, *Scott* . . . * "*Scientific American Sup.*," 1886.
High pressure, *Scott* . . * "*Engineering*," xxiv 412.
Shaw . . . . . * "*Scientific American Sup.*," 1410.
"Thunderer," British Navy . . . . . * "*Engineer*," xlii. 133.

Ma-rine' Drag. A drag-anchor. A floating anchor; thrown overboard in a storm to keep the ship's head to the wind when disabled or lying to.

Fig. 1676.



Capt. Beals' Marine Drag.

See DRAG-ANCHOR, Fig. 1738, p. 737, "*Mech. Dict.*"

Ma-rine' En'gine. The engines of the steamships of the American line, "Pennsylvania," "Ohio," "Indiana," and "Illinois," were built by the William Crump & Sons Ship and Engine Co., of Philadelphia. The vessels are of 3,030 tons, have a length of 355′ over all, and a beam of 43′. The engines are shown by longitudinal and transverse vertical sections in Plate XXVIII., and by plan in Fig. 1677.

"The engines are independent, compound, and surface condensing, with the crank set at right angles. The cylinders are 57¼″ and 90½″ in diameter, respectively, and the stroke of pistons is 4′. The main slide valves are on the outside of the high and low-pressure cylinders, which are both inclosed in a jacket connecting them together, and forming a receiver. The high-pressure cylinder is also steam-jacketed, but the low-pressure cylinder is not. The pistons are 16¾″ deep; the rod for the high-pressure cylinder is 8″, and that of the low-pressure 8½″ in diameter, and both are carried upwards through the cylinder heads. The cross-heads are of wrought iron, with cast-iron slides bolted to their ends. The main slide valves have double ports, each is fitted with an independent cut-off valve on the back, no provision being made for counterbalancing the pressure on the valve faces. The weight of the main valves is counterbalanced by the steam pressure in a cylinder on the top of the steam chest. Both main valves are driven by motion of the double bar-link type.

"The engines are reversed by direct-acting steam gear, the reversing cylinder being 20″ in diameter, with a slide valve on top, which is thrown open by hand, and closed by the motion of the piston-rod in any position. A screw is also provided which can be clamped to the piston-rod of the cylinder so as to move the links by hand if there is a want of steam.

"Relief valves are fitted at the end of each cylinder with gear to use them as starting valves. The connecting rods are forked by the cross-heads and are fitted with strap ends. The cross-head journals are 10½″ in diameter and 10½″ long, and the crank-pins are of steel 15½″ in diameter and 20″ length of journal. The crank-shafts are built up in two lengths, and are made interchangeable; the main journals are 15½″ in diameter and 30″ long, except the forward journal, which is 24′ long. The cranks are counterbalanced.

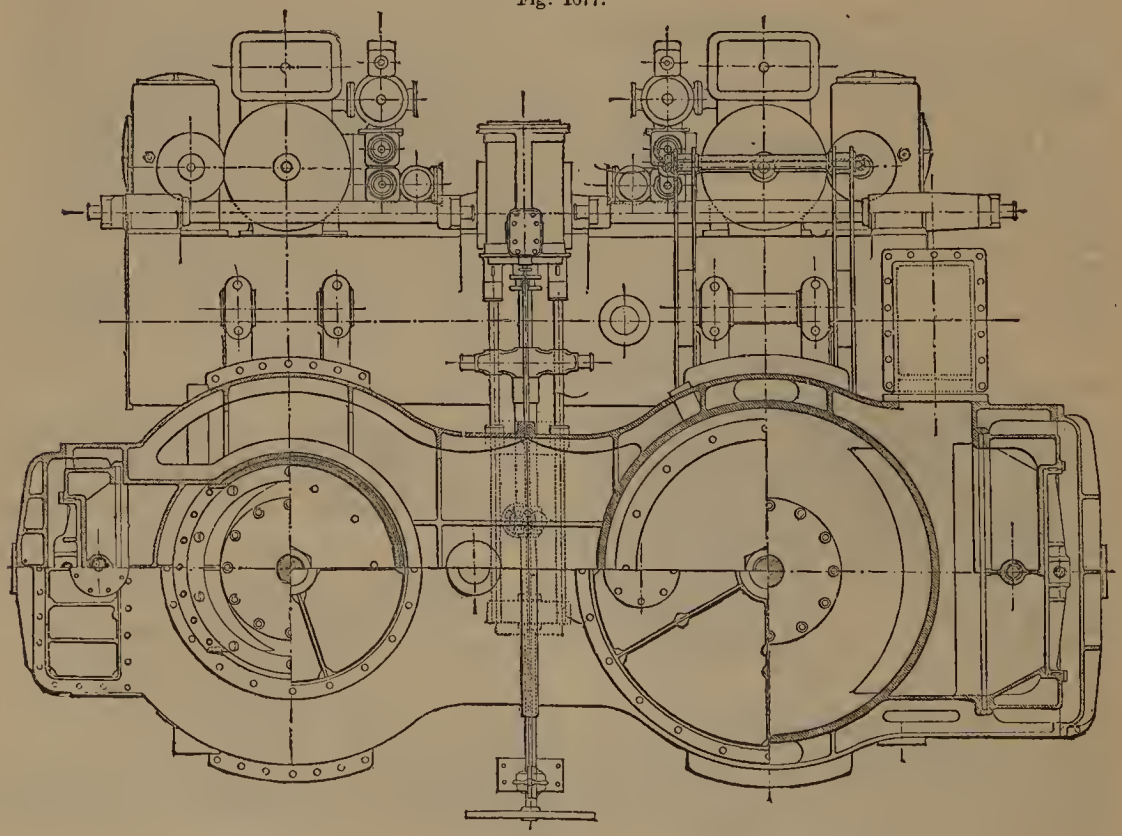
"The bed-plate is made in two parts and is bolted up to the condenser. This latter is in two pieces and contains 1,492 tubes, ⅝″ in diameter and 14′ long, the surface exposed being thus 4,786 square feet. The water from one circulating pump passes through them three times and from the other twice. The pumps are worked from the main cross-heads through wrought-iron levers as shown. Each air and circulating pump is cast separately and bolted to the condenser. A feed and a bilge pump are bolted to each air pump. The latter are 26″ in diameter, the circulating pumps are 18″ in diameter, and the feed and bilge pumps are each 6″. The stroke of all is 26″.

"A vertical turning engine is bolted to the side of the condenser and gears into a worm-wheel fastened to the intermediate shaft coupling between the two cylinders. The propeller shaft is 15½″ diameter, and is sheathed in the stern pipe. The propeller is four-bladed, with the blades cast separately and bolted to the bars; the diameter is 17′ and the pitch 24′.

"The boilers are double-ended, three in number, and fired fore and aft. The diameter of each is 12′ 3″ and the length 17′. There are three furnaces in each end 2′ 10″ in diameter, with grate bars 5′ 4″ long. There are 316 tubes 3″ in diameter and 7′ long in each boiler."

The compound has become the most popular, as it is the most economical, of marine engines. Reference has been made to 52 examples in COMPOUND STEAM ENGINE, p. 215. *supra*.

Fig. 1677.



Plan of Engines, "Ohio," "Indiana," etc., of the American Steamship Line.

ENGINES OF THE STEAMSHIPS "PENNSYLVANIA" "OHIO," "INDIANA," AND "ILLINOIS."

CONSTRUCTED BY THE WILLIAM CRAMP AND SONS' SHIP AND ENGINE BUILDING COMPANY, PHILADELPHIA.

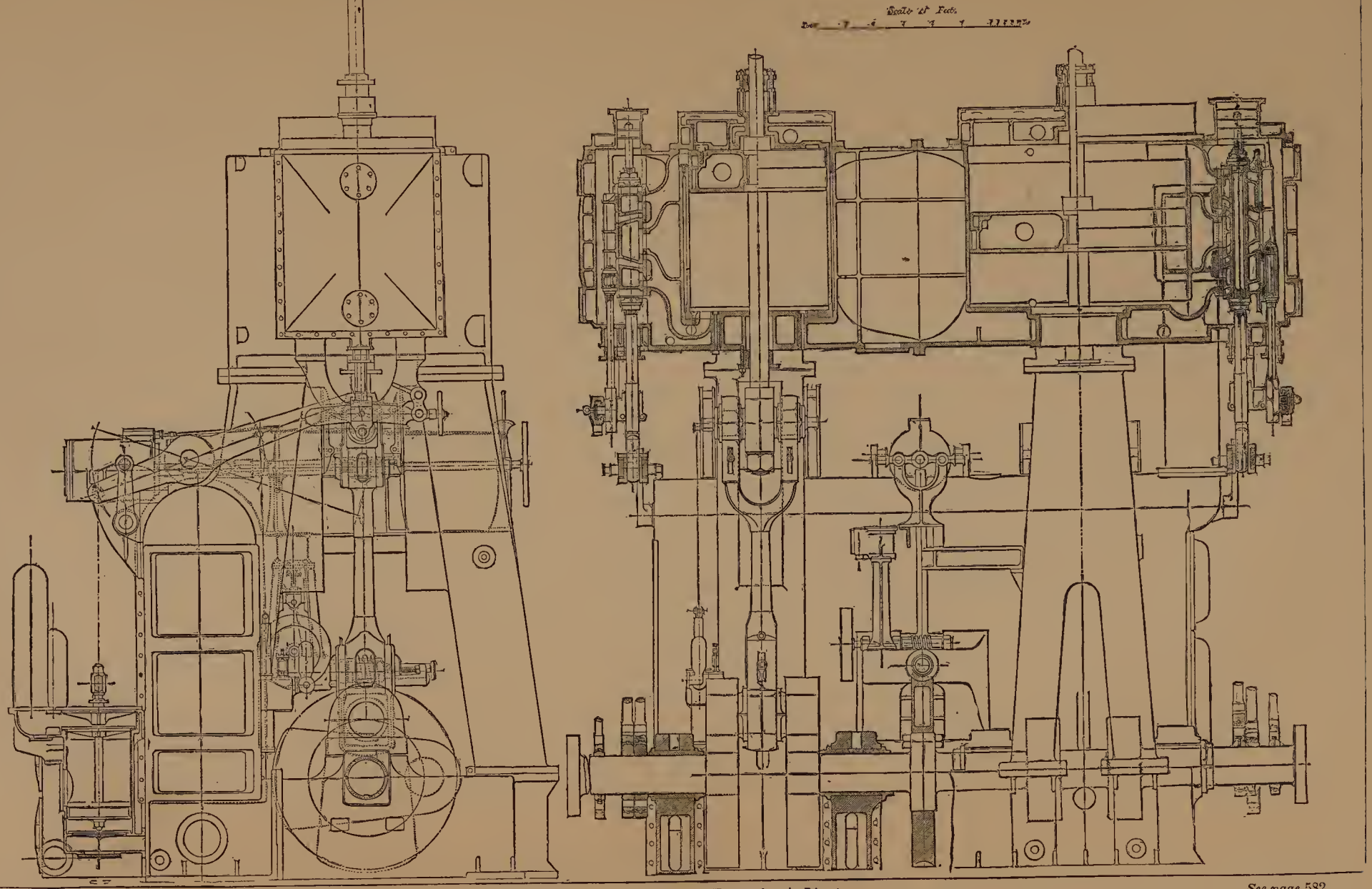


PLATE XXVIII.

MARINE ENGINE. (*American Transatlantic Line.*)

See page 582.

"The running of the Ohio during the voyage from Queenstown to Delaware Breakwater on her second voyage, was as follows: —

Date.	Knots Run by Screw.	Knots Run by Observation.	Running Time.	
Oct., 1873.			*hours.*	*min.*
17	246.8	226.0	18	59
18	323.8	280.7	24	23
19	338.5	322.0	24	15
20	335.7	294.0	24	23
21	331.0	No obser.	24	0 { 15 minutes detention.
22	341.5	No obser.	24	24
23	336.7	946 in 3 days	23	43 { 18 minutes detention.
24	339.5	333.7	24	22
25	343 2	341.0	24	21
26	142.0	140.0	10	30
	3,075 7	2,863.4	9 days, 7 hours, 20 min.	

"The slip of the screw amounted to 212.3 knots, or 6.8 per cent., while the average speed was 12.8 knots. The weather was calm. Average indicated horse power, 1,977.54.

"That the performance of the engines we have described has been most satisfactory is proved by the great regularity of the passages made by the vessels to which they are fitted, while their workmanship and general finish well deserve praise." — "*Engineering.*"

The change from *paddle* to *screw* has revolutionized the forms of marine engines. The necessity for placing the propeller shaft near the keel has placed the engine above it, and the proximity of the keel and consequent short radius of the crank has reduced the stroke of the piston.

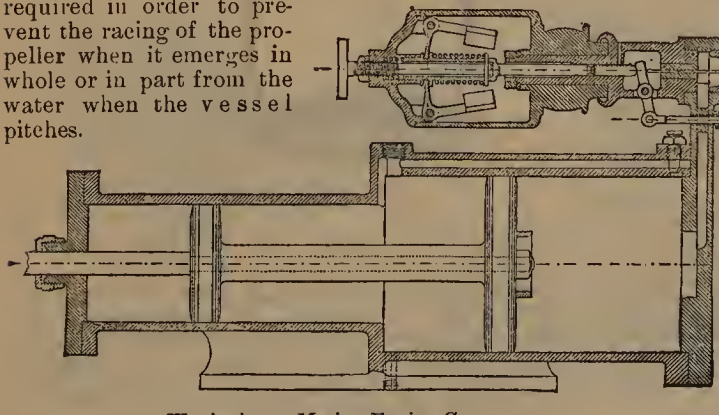
See the following: —

Torpedo launch "Acheron," N. S. Wales . . * "*Engineering*," xxviii. 99.
"Calais-Douvres" . . * "*Engineer*," xlv. 400.
Ericsson's "Destroyer" * "*Engineer*," xlvi. 457.
Compound, "Gallia"
Thomson, Br. . . . * "*Engineering*," xxviii. 220.
German Iron clads . . * "*Engineering*," xxiii. 10.
"Hudson," Cromwell line . . . . . * "*Engineer*," xlii. 242, 320, 390; xliii. 236, 388, 431, 462.
* "*Scientific American Sup.*," 959.
Irish Channel Steamers * "*Scientific American Sup.*," 1394.
Surface cond. oscillating
"Lord of the Isles," Br. . . . . * "*Engineering*," xliv. 66, 115, 132.
"Loudoun Castle" . . "*Scientific American Sup.*," 1252.
"Old Colony," . . . . * "*Sc. American*," xxxviii. 322, 323.
"City of San Francisco,"
Roach . . . . . * "*Engineering*," xxiii. 228.
Cond., oscilla. disconnecting
"Silva Americana" . . * "*Engineer*," xliv. 149.
Eng. and boilers. "Tourmaline," British Navy * "*Engineer*," xliii. 284.
White Star "Britannic" * "*Engineer*," xlii. 294.
Young . . . . . "*Scientific American Sup.*," 1011.

See also, COMPOUND STEAM ENGINE

Ma-rine' En'gine Gov'er-nor. An apparatus for controlling the speed of the screw; a particularly rapid action being required in order to prevent the racing of the propeller when it emerges in whole or in part from the water when the vessel pitches.

Fig 1678



Westinghouse Marine Engine Governor.

The subject has been considered in the "*Mech. Dict.*," and the following referred to at the pages noted: —

Huntoon, * *q q'* Plate XXI., opposite p 998.
Huntoon, * Fig. 4750, p. 2073
Silver, * Fig. 3063, p. 1394.
Cathcart, * Fig. 3067, p. 1394.
Duff, * Fig. 3068, p. 1395.
Wolcott (electro-mag.), p. 1395.
Mosman (chronometric), p. 1395.
Osborne, p. 1394.

The principle embodied in the Westinghouse marine engine governor is the employment of steam pistons as the medium for operating the throttle-valve or link, and the only duty of the governor is to actuate a small piston valve which controls the pressure of steam on opposite sides of these pistons, thus varying their position, and also that of the throttle-valve or link to which they are attached.

The apparatus consists of two parts, a differential cylinder and a regulator; the former contains a piston-rod, one end of which is connected to the starting valve of the engine, and the other passes through a long tube or sleeve, carrying at either end a piston fitting the differential cylinder just mentioned.

The apparatus is shown in Fig. 1678; its operation is as follows: —

Steam is admitted into the large and small parts of the cylinder so that the pressure on each side of the larger piston is equalized, while the pressure on the smaller piston keeps it at the end of its stroke, that is, to the left in the cut, the opening in the end of the smaller cylinder leading to the air or condenser. This position keeps the engine valve open and this is the normal running condition. The portion of the regulator containing the weights is driven by a strap from the engine, and, as soon as racing commences, the increased speed given to the revolving weights causes them to fly outward and depress the regulator spindle which acts upon a piston valve and allows the steam to escape from the right hand side of the larger piston, to the atmosphere, reducing the pressure on that side of the piston. The pressure of steam on the larger piston then instantly overbalances that on the smaller one and the pistons fly to the right and thereby close or partially close the valve admitting steam to the engine. The speed is by this means instantly reduced, the piston valve returns to cover the port in the regulator chamber, and the pressure is restored to equality on each side of the large piston.

Durham's screw engine governor acts also on the principle of the combination of a governor with a steam cylinder and piston.

Refer to: Governor, pneumatic, *Dunlop*, Br. . . * "*Engineer*," xlviii 103.
Jenkins & Lee . . . * "*Engineering*," xxx. 370.
Durham, Br. . . . . * "*Scientific American Sup.*," 2397.
Westinghouse . . . . * "*Engineering*," xxvi 177.
* "*Am. Man.*," p. 9, May 2, 1879.
Russian navy.
* "*Engineering*," xxi 326

See also, GOVERNOR.

Ma-rine' Pump. A pump for steamboats, steamships, and nautical purposes generally, requiring large open valves and passages to prevent choking. The term also includes boiler feeding pumps, circulating, fire, bilge-water, and perhaps wrecking pumps. Cylinders are preferably composition lined and piston-rods solid composition; the pistons are composition, with spring rings, or arranged for leather.

Mar'in-er's Com'pass. The history, early notices, and modern instances of the mariner's compass are given on pp. 1395–1398, "*Mech. Dict.*"

Figs. 1679, 1680 are respectively plan and section of Sir William Thomson's mariner's compass, designed, as the inventor says, "to carry out in practical navigation the principles developed by Astronomer-royal Airy.

Sir George Airy, in 1840, showed how the errors of the compass, depending on the influences experienced from the iron of the ship,

may be perfectly corrected by magnets and soft-iron placed in the neighborhood of the binnacle. The system has become universal. The principal difficulty in practice "has been the size of the needles in the ordinary compass which

Fig. 1679.

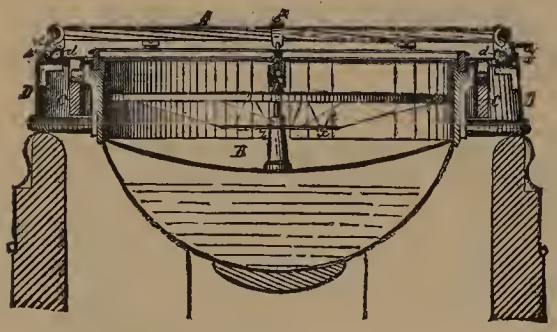
Sir William Thomson's Mariner's Compass. (*Card.*)

renders one important part of the correction, the correction of the quadrantal error for all latitudes by masses of soft iron placed on the two sides of the binnacle, practically unattainable; and which limits, and sometimes partially vitiates the other chief part of the correction, or that which is performed by means of magnets placed in the neighborhood of the compass.

See paper by Sir William Thomson, United Science Institution, * Feb. 4, 1878. See United States Patent No. 232,781.

In size and outward appearance this compass (with binnacle, etc.), does not differ from those hitherto in use; but the patent card is constructed on an entirely new principle. It consists of a central aluminium boss and an outer aluminium rim connected together by fine silk cords. Small

Fig. 1680.



Sir William Thomson's Compass. (*Section.*)

magnets from 2″ to 3″ long are suspended by means of silk cords from the rim, and thin paper marked with the points of the compass and degrees is attached to the rim and partially supported by the silk cords between the rim and the boss. By this arrangement the principal part of the weight is in the aluminium rim, and is consequently as far as possible from the center on which the card moves. This gives a very long period of free oscillation, and, consequently, great steadiness.

The card with the needles is extremely light, the 10″ compass weighing 178 grains, which is about one twentieth of the weight of an ordinary compass of such dimensions. The *frictional error* is thus reduced to a very small amount.

The *quadrantal error* in this compass is corrected by a pair of soft iron globes fixed one on each side of the binnacle. When the quadrantal error has been thus once accurately corrected, the correction is perfect, to whatever part of the world the ship may go, and requires adjustment at no subsequent time, except in the case of some change in the ship's iron, or of iron cargo or ballast sufficiently near the compass to introduce a sensible change in the quadrantal error.

The *semi-circular error* is corrected by applying two adjustable magnetic correctors, one for neutralizing the thwart-ship component, the other for the fore-and-aft component of the ship's magnetic force.

The *heeling error*, chiefly experienced in iron sailing ships, is corrected by the application of an adjustable magnet below the compass in a line through its center perpendicular to the deck.

Cf. Japanese	"*Telegraphic Journal*," iv. 212.
Sir W. Thompson . .	* "*Engineering*," xxiii. 191.
	"*Scientific American Sup.*," 1084.
Nickel needle	"*Scientific American Sup.*," 2686.

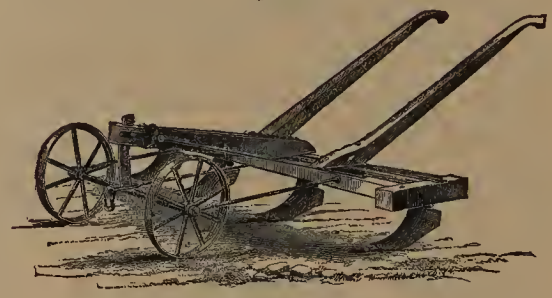
Ma-rine' Sig'nal. The term includes many kinds of apparatus, such as whistling, ringing, and electric buoys, fog horns, guns, and trumpets, sirens, etc. See under various heads.

Prof. Meyer's topophone for locating sound, Patent No. 224,199.

Safety signal, *Barker*	* "*Engineer*," xlix. 411.
Signal buoy, *Mann*	Patent No. 226,238.

Mark'er. (*Agriculture.*) An implement for marking off rows on the ground as a guide for planting or dropping.

Fig. 1681

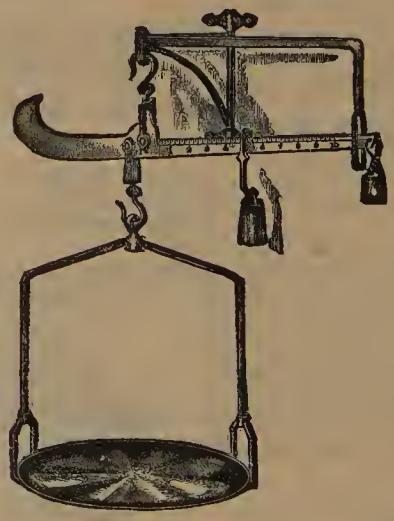


French Row-marker.

The one shown is a French implement,—*rayonneur*—used in marking rows for planting beets and other drill crops.

Mar'ket Beam. A form of steelyard of spe-

Fig. 1682



Market Beam.

cial adaptation to market purposes in its range of weight, means of suspension, and large pan.

See scales, Plate LXXIII., p. 2754, "*Mech. Dict.*"

Mark'-off. (*Printing.*) In proof-reading, the slip of copy upon the margin of which the termination of a page of proof is marked. This in order to assure the proper sequence in the commencement of the next page.

Mar'lin-spike Hitch. (*Nautical.*) A form of bend. See *g*, Fig. 2513, p. 1105, "*Mech. Dict.*"

Mar'tin Bit. (*Manége.*) A stiff bar bit, having a spoon-shaped port, from $4\frac{3}{4}''$ to $6''$ long and $\frac{1}{2}''$ wide; the top is convexed and polished; when in use, this long piece rests against the roof of the horse's mouth, and when necessary it becomes unusually severe, yet it does not injure the mouth as much as other port bits.

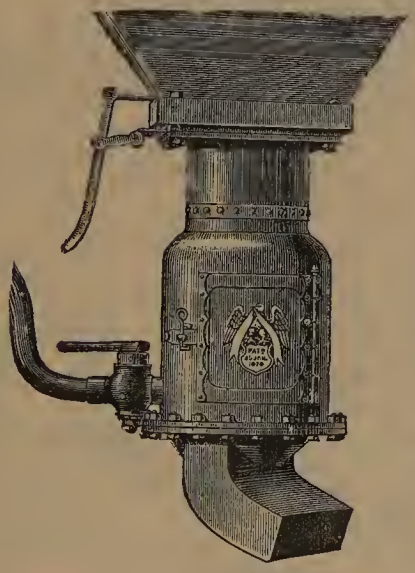
Mar'tin Steel. (*Metallurgy.*) Steel made by adding malleable iron to a bath of pig-metal in a reverberatory. P. and É. Martin, Patents, 1865–1867. A Siemens-Martin ingot, weighing 120 metrical tons, was cast by the Terre Noire Company, in 1878.

Ma-ryn'go-tome. (*Surgical.*) A fine hastate pointed instrument of incision; used in operations on the ear. — *Buck.*

Mash Ma-chine'. A machine for pulping mash before discharging it into the tun where it is steeped.

Siebel's device, shown in Figs. 1683, 1684, is a sparger used to soften and pulp the mash on its way from the hopper to the

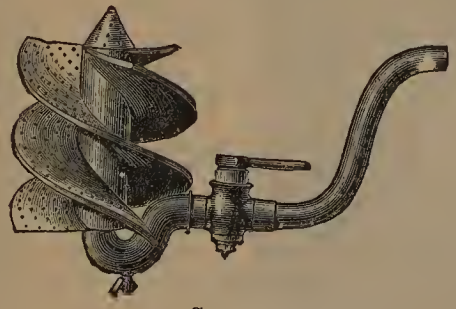
Fig. 1683.



Siebel's Malt Pulper.

tun. Fig. 1683 is an exterior view of the apparatus, and Fig. 1684 a view of the interior sparger. It consists of a hopper, sparger chamber, and spout, and a pipe and worm with perforations to eject water to suffuse the passing malt. The gate valve at the bottom of the hopper being withdrawn, the ground malt in the hopper commences to descend; hot water is admitted to the sparger by turning the spigot. The

Fig. 1684.

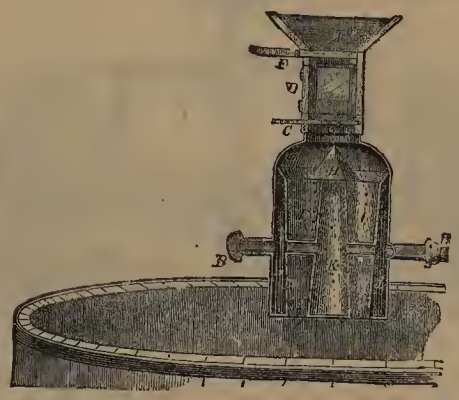


Sparger.

vertical portion and the spiral of the latter are hollow and perforated, to discharge jets of hot water arriving by the pipe. The descending malt is spread by the cone, and, passing down the face of the spiral is reduced to a soft pulp before being discharged by the chute into the tun beneath.

In *Trageser's* self-acting mashing machine the malt enters from the hopper *A*, strikes the cone *H*, and passes down

Fig. 1685.



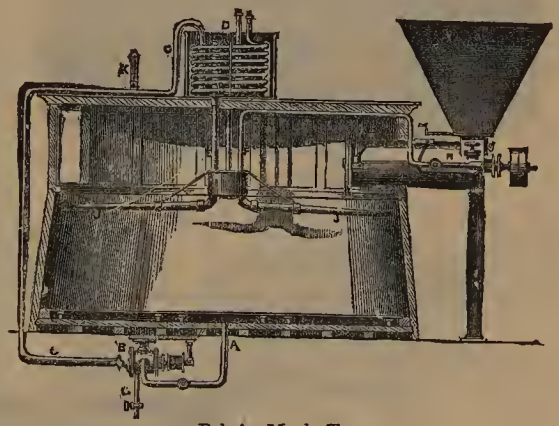
Trageser's Sparger.

an annular space *I* between two cones *J K*. Water from pipe *B* surrounds the outer cone and fills the inner one, and is sparged through perforations upon both sides of the malt passing downwards into the tun.

Mash Tun. A vat in which ground malt is steeped and stirred to make wort. See Figs. 3077–3080, pp. 1402, 1403, "*Mech. Dict.*"

Fig. 1686 is *Boby's* mash-tun (Br.), which is adapted for mashing at a low temperature, and subsequently increasing the heat, avoiding the use of successive amounts of hot water; called in England *piece liquors.*

Fig. 1686.



Boby's Mash Tun.

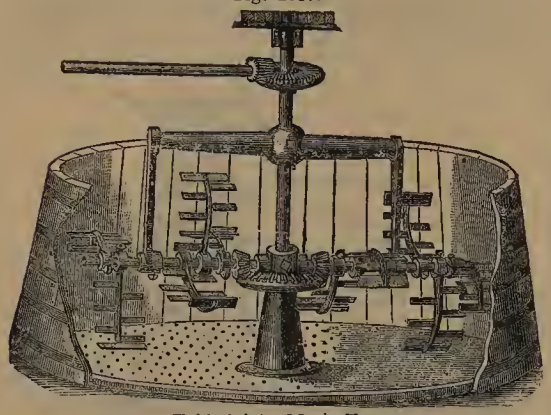
In the figure —

A Pipe provided with stop-cock, to convey wort from bottom of tun to pump.
B. Pump with rigger, to be driven by means of a strap.
C. Pipe which conveys wort from pump into copper cistern with coil
D. Copper cistern containing coil for heating wort.
E. Tube from coil cistern to sparge.
G. Tube with cock for the purpose of emptying pump and pipes after the operation.
J. Sparge arms
K. Thermometer, indicating temperature of wort in tun.

The peculiarity of *Feiderlein's* mash tun (Fig. 1687) is in the mechanism. It has a strong perpendicular driving shaft, by which the whole system of rakes is revolved in a horizontal plane. The rakes revolve in vertical planes, and are journaled upon a horizontal shaft which itself has a rotary sweep in addition to its axial rotation. The double-armed rake lifts the malt on both sides of the tun at once.

Fig. 1688 shows *Schimper & Immen's* mash machine, a portion of the side of the tun being broken away to exhibit the apparatus and interior. The stirrer consists of a spiral which rotates with its horizontal shaft, and partakes with the latter of a sweeping movement in a horizontal plane around the vertical axis to which it is attached. The movement of rotation of the screw is given by the meshing of a pinion on the horizontal shaft with a bevel wheel on the floor of the tun. The mash is heated by a steam coil above

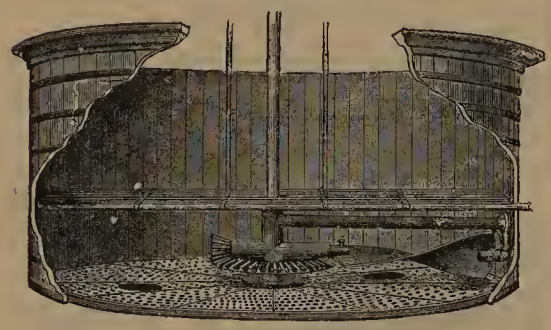
Fig. 1687.



Feiderlein's Mash Tun.

the agitator. The arrangement prevents the accumulation of the solid contents at the bottom of the tun; the currents created by the compound motion of the screw — of translation about the vertical axis and of rotation about its own horizontal axis — maintains a constant circulation between the center and the perimeter of the bottom of the tun; a vertical circulation taking place at the outer walls of the tun and also in the center.

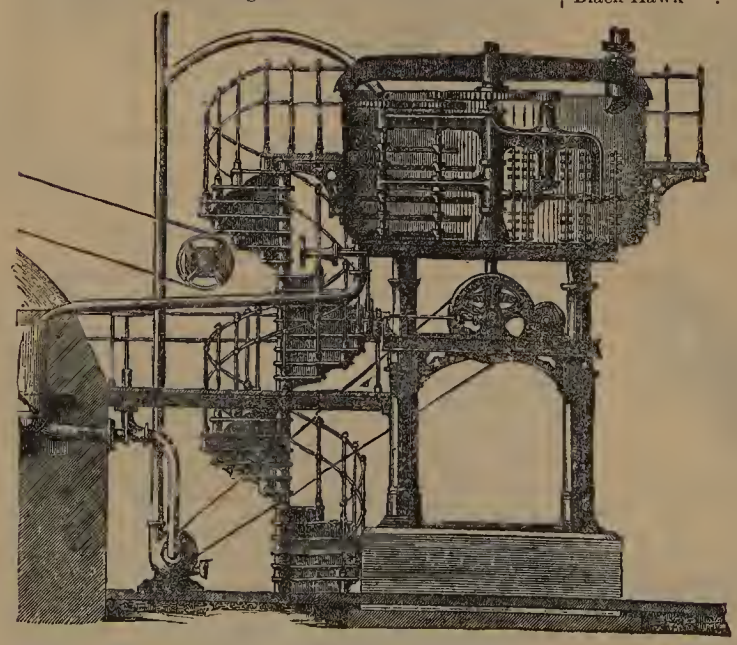
Fig. 1688.



Mash Machine.

The mash tun of *Noback, frères*, of Prague, is shown in Fig. 1689. The figure shows the boiler, pump, tun, and mechanism for stirring; also the pipe and band connections. The stirrer has a revolution of translation in a horizontal plane around the vertical axis. The arms on the sides of the axis have respectively rakes revolving in horizontal and vertical planes so as to leave no corner or surface of the mash tun unvisited.

Fig. 1689.



Mash Tun. (Noback, Prague.)

Ma'son-ry. The various kinds may be found under —

Ashlar.	Range.
Dimension stone.	Rubble.
Random.	Squared stone.

For list of masonry, varieties, tools, etc., see list under STONE-WORKING, *infra*. Also, list MASONS AND BRICKLAYERS' TOOLS AND WORK, p. 1405, "*Mech. Dict.*"

The column of Trajau is of Parian marble, constructed of circular blocks placed one above another, like so many immense mill-stones, so large and high that each makes the circumference of the pillar, there being but 17 in the shaft of the column; in all, 24, including the base and the capital, reaching 24 toises of elevation, — 152 feet.

The windows and the steps of the spiral staircase are carved out of each block.

"The most valuable pillars about Rome, for the marble of which they are made, are the —

"Four columns of oriental jasper in Ste. Paulina's chapel in Ste. Maria Maggiore.

"Two of oriental granite in Ste. Pudenziana.

"One of transparent oriental jasper in the Vatican library.

"Four of Nero-Bianco in Ste. Cecilia in Transtevere.

"Two of Brocatello and two of oriental agate in Don Livio's palace.

"Two of Gallo-Antico in St. John Lateran.

"Two of Verdi Antique in the Villa Pamphilia.

"These are all entire and solid pillars, and made of such kinds of marble as are nowhere to be found but among antiquities, whether it be that the veins of them are undiscovered, or that they were quite exhausted upon the ancient buildings." — *Addison.*

See also paper on "*Ancient Roman Works*," by Nash, read before the "Architectural Association" of England. Published in "*The Builder*" and republished in "*Van Nostrand's Eng Mag.*," xvii. 464-472.

Cf. Gillmore's "Building Stones."

Ma'son's Ham'mer. A steel hammer weighing from 3 to 8 pounds, having a square face, and an edge peen, the line of the latter in the plane of the sweep of the handle.

Mast. The following list gives the full height of the masts of a number of vessels, excluding those under 130′:—

HEIGHT OF SPARS FROM KEELSON TO TRUCK.

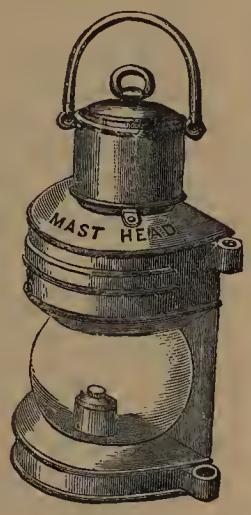
Ships.	′	″
Alexander Marshall	156	9
Great Western	162	3
Young America	205	0
Black Hawk	172	0
C. H. Marshall	154	3
Three Brothers	203	0
Invincible	190	4
Australia	170	0
John Bright	169	0
Cultivator	176	8
Baltic	174	6
James Foster, Jr.	159	9
Guy Mannering	173	11
Harvest Queen	167	8
Neptune	164	9
Ocean Monarch	179	0
Thornton	166	10
Universe	158	6
Vanguard	161	10
Isaac Webb	165	8
Manhattan	165	8
Steamships.		
China	144	0
Great Republic	141	0
America	141	0
Japan	143	0
Colon	140	0
Granada	140	0
Acapulco	140	0
City of Peking	204	0
City of Tokio	204	0
Schooners.		
Alcott	136	0
Mohawk	146	3
Wm. Mason	133	6
Dauntless	141	6
Robert Dillon	165	0

Cf. *Fincham's "Masting Ships and Mastmaking."*
Kipping's "Treatise on Masting and Rigging."
"Treatise on Sails and Sailmaking."

Mast Head. (*Nautical.*) The upper part of a mast above the rigging.

Mast-head' Lamp. (*Nautical.*) A signal and sailing lamp swung aloft as a caution to other craft.

Fig. 1690



Mast-head Lamp.

Mast-head' Pen'dant. (*Nautical.*) A short piece of rope fixed upon the head of a mast under the shrouds, having at its end an iron thimble spliced into an eye, to receive a hook of a tackle.

Mast Hinge. (*Nautical.*) A socket for setting up a boat's mast, and allowing it to be struck by unstepping it at the keel.

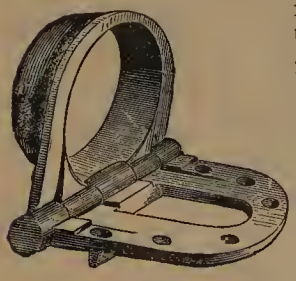
Mast Lin'ing. A thickness of cloth on a sail to prevent chafing against the mast.

Mat. 1. (*Nautical.*) A plaited rope fabric used to bind on shrouds or spars to prevent chafing. It is made of strands of old rope, spun yarn, foxes, sennit, etc.

See: Paunch mat. Sword mat.
Sennit. Thrum.
See list under SEIZING.

2. (*Hydraulic Engineering.*) 1. A woven structure of willows, weeds, or brush, secured by ropes or wires into a continuous mat, and used as a revetment for river banks. See MATTRESS.

Fig. 1691.

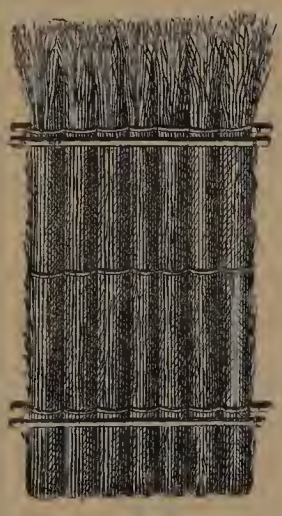


Mast Hinge.

One laid by the U. S. Engineers near Covington, Nebraska, was 2,000′ long and 69′ broad, and from 6″ to 12″ thick. It was built on a mattress boat, which gradually receded as the mat was constructed, letting the mat slip into place in the water. See "*Report of U. S. Engineers*," *1880, p. 1455.

Fig. 1692 shows a mat made of 6 or 7 fascines laid side by side, and lightly bound between 4 poles tied together in pairs at the ends and middle with lath yarn. Such a mat is about 12′ × 5′ 8″.

Fig. 1692.



Revetment Mat.

Full description of making may be found in "*Report of Chief of Engineers, U. S. Army*," 1876, * vol. ii., Part II., p. 404. Mats are used to anchor with stones in making dams or jetties: as a revetment to banks, to prevent scour of river bottoms, etc.

3. A species of rug, for the feet.

Felt mats are made by the following process: A piece of felt of suitable thickness is cut into strips ⅜″ to ⅝″ in width, and as long as the mat is to be wide. These are laid side by side on edge, and holes are made through them, and through these holes cords of fine wire are passed, and the strips are then drawn tightly together and fastened in place at each end of the wires. This gives a fabric as thick as the strips are wide, and of a light, flexible, and elastic character. The strips may be in various colors and may be disposed in any desirable pattern. When finished, the mats have a good face on either side.

4. A floor covering, or substitute for carpet.

The ordinary Japanese mats are made of the materials mentioned below and lined with rice straw, are more than 1″ thick, and throughout Japan are all of the same size, viz., 6′ by 3′.

The surface of the mats in rooms, and mattings of better quality in general are made of the *Juncus effusus*, — the pith of which is used for candle- and lamp-wicks, — in the province of Oomi; of the *Isolepis*, in Bingo, and of the *Cyperus rotundus*, in Satsuma and Bungo. For the commoner mattings rice straw and also different kinds of rushes are used; for instance, *Scirpus lacustris*, *Hydropirium latifolium*, and typha, which plants grow almost everywhere. Rain cloaks are also made of certain kinds of grass or of palm-leaves.

Fluted portable matting . . . *"*Man. & Builder,"* xi. 43.
Malakoff mantelet . . . . . Fig. 1673, p. 580, *supra*.

Mat Boat. (*Hydraulic Engineering.*) A frame of ways supported on scows, on which mat for revetment is woven, and from which it is launched into place to act as a preventive of scour on a river bank or elsewhere.

Match. Considered on pp. 1408, 1409, "*Mech. Dict.*"

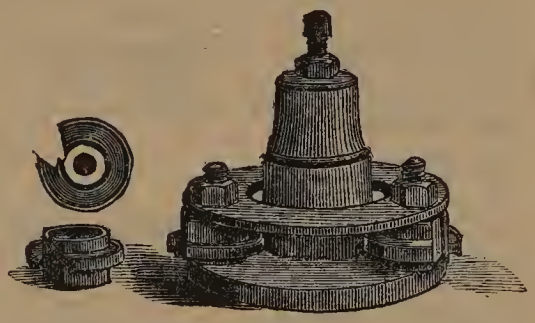
Process of match-making in France described under article "*Allumettes*," *Laboulaye's "Dictionnaire des Arts et Manufactures*," vol. iv., ed. 1877.

American process . . . "*Harper's Weekly*," June 22, 1878.
"*Scientific American Sup.*," 1332.

Match'er Head. (*Wood-working.*) The head in a planing machine which carries the cutting tool.

Fig. 1693 shows a form in which the cutting tool — either the grooving or the tongueing cutter — is a solid circular

Fig. 1693.



Matcher Head.

disk secured between the plates of the head by a bolt running through its center, and projecting from the periphery of the plates a sufficient distance to cut the groove and clear the edge of the board. The cutters are 2½″ diameter and afford about 7″ cutting surface, being filed back as they wear.

Match Hook. A tackle hook, consisting of two portions which shut together, each forming a mousing for the other. A *sister* hook.

Fig. 1694.

Match Hook.

Ma-te-lasse'. (*Fabric.*) A silk-and-wool French dress goods.

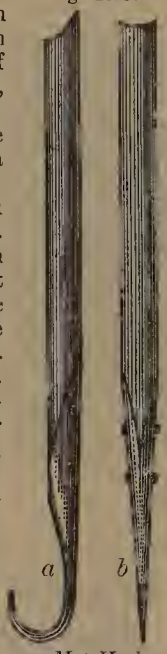
Mat Hook. A long pole with an iron hook, used to hook on to the binding pole of a mat. Used also in handling the mats in floating into place

and holding while being anchored with stones. See under JETTY, p. 512, *supra*.

See Figs. 10, 12, "*Report of Chief of Engineers, U. S. Army*," 1876, vol. ii., Part II. Appendix X. 4, pp. 408, 409.

Mat Pole. (*Hydraulic Engineering.*) A pole 20′ long, 3″ in diameter, smoothly shaved and iron pointed, used in placing mats of brush for shore protection, jetties, etc. See MAT HOOK.

Fig. 1695.



a. Mat Hook.
b. Mat Pole.

Ma'trix. 1. (*Mining.*) The rock or earthy matter containing a mineral or metallic ore.

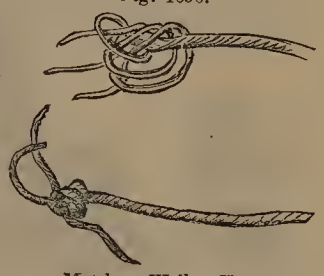
2. (*Dentistry.*) A mold used in filling proximal cavities in teeth. The matrix is a slip driven between the teeth, its wedging side against the abutting tooth and its concave side against and agreeing with the cavity to be filled. — *Dr. Louis Jack.*

Ma'trix Rol'ling Ma-chine'. A machine which in large establishments takes the place of the beating table and brush. Fig. 5800, p. 2380, "*Mech. Dict.*" The work of the machine is to force down the prepared matrix paper into the type in taking a cast thereof by the paper process; described on p. 2380 above cited.

Mat'thew Walk'er. A form of knot something like a double wall knot.

To make it: Unlay the rope for 10″ or 12″; pass the first strand around the rope and bring the end up through the bight thus formed; pass the second strand around the rope and bring the end up through both bights; pass the third strand around the rope, and bring the end up through the three bights; haul the ends gently until the knot is in shape, then haul tight, and finish with a crown. The cut shows the strands laid through the bights and also hauled tight.

Fig. 1696.



Matthew Walker Knot.

Mat'tress. (*Hydraulic Engineering.*) A mass of woven withes, poles, brush, willows, or what not, used to place on a bank or shore to preserve it against the impact of water and prevent erosion by the current.

There are many modes of building, and among the most remarkable instances to be found are the maritime and interior dyke works of Holland and the Eads' improvements of the southwest pass of the Mississippi. Good illustrations of methods are to be found in Plates I. to XIV. opposite p. 1380, vol. ii., "*Report of Chief of Engineers, U. S. Army*," 1880.

See also mattresses of Galveston jetty, same work and volume, * p. 1228.

A good account of all the tools and methods used at Nebraska City is given in the "*Report of the Chief of Engineers U. S. Army*," 1879, * ii. 1074.

It includes the following: —

Harpoon shuttle.	Shuttle fastening.
Brush jack.	Hook needle fastening.
Brush jack needle.	Mattress fastening.
Hook needle.	Curved needle fastening.
Curved needle.	Various kinds of sewing.
Jack fastening.	

Drawings and descriptions of elaborate mattress work on the Mississippi River may be found in the "*U. S. Engineers' Report*," 1879, * ii. 1111, 1118.

Charleston harbor	* *Ibid.*, i. 736.
Savannah river	* *Ibid.*, i. 742.
Arkansas river	* *Ibid.*, 1878, ii. 658.
Mississippi jetties	* "*Scientific American Sup.*," 332.

Among the various tools used in making revetment mattresses are the following, which are described under their various headings, *supra*: —

Brush jack.	Harpoon shuttle.
Brush jack needle.	Hook needle.
Curved mattress needle.	

To these may be added the following names of types of revetment work, which see: —

Apron.	Mat.
Curtain.	Revetment.
Floating brush dike.	Sand fence.
Floating wire dike.	Willow curtain.
Hurdle.	

Mat'tress Boat. (*Hydraulic Engineering.*) A boat on which a mattress is built and from which it is launched. Such mattresses are used in revetments of banks or the prevention of scour of bottoms, also in making dikes to act as dams, chutes, or breakwaters.

Views and details of mattress boats as used on the Mississippi are to be found in "*Annual Report of Chief of Engineers, U. S. Army*," 1880, * ii., pp. 1418, 1439.

A mattress boat consists essentially of a set of 8 trussed ways supported by two scows. The ways upon which the mattresses are made form the upper chords of the trusses. See also Plate I., and p. 1074, vol. ii., "*United States Engineer's Report*," 1879.

May'nooth Bat'te-ry. (*Electricity.*) In a cast-iron pot containing nitro-sulphuric acid is placed a porous jar which contains the amalgamated zinc and dilute sulphuric acid.

Niaudet, American translation	175.
"*Scientific American*"	xl. 123.

Meal Cool'er. A process in which the meal from the millstones is conducted along a passage in which is a current of air induced by a fan, in order to remove the heat generated by attrition between the stones.

Seen in *Vallod's* French patent, 1836.
Deuchfield's United States patent, 1858.
Robinson's English patent, 1853.

Cartier, French	"*Laboulaye's Dictionnaire*," 1854
Webster	* "*American Miller*," viii. 146.
	* "*American Miller*," vol vi.

Meas'ur-ing, Cal'cu-la-ting, Test'ing, and Re-cord'ing In'stru-ments. Subjects in these classes are considered under the following heads: —

Abacus.	Azimuth instrument.
Absorptimeter.	Bag weigher.
Actinometer.	Balance.
Adding machine.	Balance dynamometer.
Adding pencil.	Bar iron tester.
Aërometer.	Barometer.
Aërophone.	Barometer flowers.
Aërothermic balance.	Barometric balance.
Æsthesiometer.	Barometrograph.
Air testing.	Barrel gage.
Air thermometer.	Base line instrument.
Alcoholmeter.	Bathometer.
Aleurometer.	Batoreometer.
Alidade.	Beam.
Altimeter.	Belt tension apparatus.
Altitude measurer.	Besidometer.
Ammonia meter.	Bias measure.
Anemograph.	Bioscope.
Anemometer.	Blast recorder.
Anemometrograph.	Boiler indicator.
Aneroid.	Boiler prover.
Angle measurer.	Bottom.
Arithmometer.	Bridge testing car.
Arithmoplanimeter.	Cable testing apparatus.
Assaying apparatus.	Calcimeter.
Astatic galvanometer.	Calculating machine.
Astigmatism apparatus.	Calendar.
Astrolabe.	Caliper.
Astronomical time-marker.	Caliper gage.
Atmolyzer.	Caliper machine.
Audiometer.	Caliper rule.
Audiphone.	Caliper square.
Auscultator.	Calorimeter.
Autokinetic telegraph.	Campylometer.
Automatic clock.	Carburometer.
Auto-ophthalmoscope.	Cardiagraph.
Autophone.	Cardiometer.
Axilla thermometer.	Cartridge scales.
Axle set and gage.	Cash-recording machine.
Axometer.	Cathetometer.

Cement tester.
Centesimal alcoholmeter.
Centesimal scale.
Chain-testing machine.
Chair balance.
Cheiloangioscope.
Chloronieter.
Chromatrope.
Chromograph.
Chronometer.
Chromostroboscope.
Chronograph.
Chronometer
Chronothermometer.
Circle.
Circular balance.
Circular compass.
Circular spring balance.
Clepsydra.
Climatometer.
Clinical thermometer.
Clock.
Clock dial, luminous.
Clock register thermometer.
Cloth tester.
Clouds, apparatus for measuring height of.
Coal-testing apparatus.
Coinage.
Colorimeter.
Color comparator.
Combination scale-beam.
Comparator.
Compass.
Compass alarm.
Conductometer.
Conformator.
Conograph.
Control watch.
Corrective gage.
Cosmograph.
Counter.
Counter scale.
Coupon numbering machine.
Crane steelyard.
Creamery scale.
Cremometer.
Crown telephone.
Crusher gage.
Current apparatus.
Current meter.
Curve.
Cutter.
Cyclometer.
Cycloscope.
Cyrtometer.
Decimal balance.
Decimal scale.
Deep-sea thermometer.
Deep-water bottle.
Deflectometer.
Densimeter.
Dentiphone.
Diagometer.
Diagraph.
Dial.
Dianemoscope.
Diapason clock.
Dietheroscope.
Differential governor.
Differential pressure regulator.
Differential stethoscope.
Diffusiometer.
Dipleioscope.
Diplograph.
Distance measurer.
Dividing engine.
Dormant scales.
Dosimeter.
Double-beam balance.
Double coil galvanometer.
Dual telephone.
Dynagraph.
Dynagraph car.
Dynamograph.
Dynamometer.
Ebullioscope.
Echoscope.
Electrical clock.
Electrometer.
Electromotograph.
Endoscope.
Engine counter.
Éprouvette.
Equation apparatus.
Equilibrium balance.
Equilibrium scale.
Escapement regulator.
Esthesiometer.
Eudiometer.
Evaporimeter.
Even scales.
Expansion of metals apparat.
External gage.
Fare indicator.
Fare punch.
Fare register.
Fiber tester.
Fire-damp alarm.
Fire-damp detector.
Fire-damp indicator.
Fire-damp meter.
Fire-damp photometer.
Fire-damp test.
Flame manometer.
Flying sounder.
Freshet signal.
Fulgurator.
Gage glass.
Gage standard.
Galvanometer.
Gas detector.
Gas indicator.
Gas meter.
Gas tester
Gas verifier.
Girder tester.
Glaucometer.
Globe.
Gluten tester.
Goniometer.
Gradientor.
Grain measurer.
Grain register.
Grain scale.
Grain weigher.
Gravity indicator.
Grisoumeter.
Grist toller.
Harmonic analyzer.
Harmonograph.
Hay scales.
Heat meter.
Heat regulator.
Heliometer.
Helioscope.
Heliotrope.
Hemarheumoscope.
Holophote.
Horograph.
Horological instruments.
Horse-power computing scale.
Hydra.
Hydraulic gage.
Hydro-dynamometer.
Hydrometer.
Hydro-pyrometer.
Hydro-rheostat.
Hydrostatic weighing mach.
Hygrometer.
Hygroscope.
Ice balance.
Inclination compass.
Index plate.
Induction balance.
Inductometer.
Inductophone.
Integrator.
Interference apparatus.
Internal gage.
Internal pressure gage.
Iron scales.
Kaleidoscope.
Kerosene tester.
Lactodensimeter.
Lactometer.
Lactoscope.
Lap scale.
Laryngostroboscopic apparat.
Letter balance.
Level.
Leveling instrument.
Lifting machine.
Light registering apparatus.
Log.
Logograph.
Log scale.
Lubricant tester.
Luminous dial.
Lysimeter.
Magnetometer.
Magnophone.
Manometer.
Mariner's compass.
Mariotte's tube.
Market beam.
Market scale.
Maximum thermometer.
Measure.
Measuring faucet.
Measuring instrument.
Measuring machine.
Measuring tap.
Meatoscope
Megalographe.
Megaphone.
Megascope.
Megohm.
Melodiograph.
Meteorograph.
Metric system.
Microhm.
Micrometer.
Micrometer caliper.
Micrometer screw.
Microphone.
Microphone relay.
Microtasimeter.
Microtelephone
Mile-stone.
Milk glass.
Milk scale.
Milk test.
Minimum thermometer.
Mirror barometer.
Mirror galvanometer.
Molarimeter.
Motion indicator.
Motion timer.
Motograph.
Motophone.
Movement.
Multiplicator.
Myograph.
Napier's bones.
Nap meter.
Natrometer.
Navigational sounding mach
Navisphere.
Numbering stamp.
Octoplex telegraph.
Odoutograph.
Office watchman.
Ohm.
Oil gage.
Oil tester.
Oleometer.
Opeidoscope.
Ophthalmoscope.
Optometer.
Orograph.
Oroheliograph.
Oscillometer.
Otheoscope.
Otoscope.
Ozonoscope.
Pachymeter.
Package balance.
Pantograph.
Pantometer.
Paper tester.
Papyrograph.
Pedometer.
Pendulum.
Perambulator.
Petroleum tester.
Phanero-grisoumeter.
Phoneidoscope.
Phonic wheel.
Phonograph.
Phonomotor.
Phonoscope.
Phosphorescent dial.
Photographometer.
Photoheliosoope.
Photometer.
Photophone.
Picnohydrometer.
Picnometer.
Piezometer.
Pig-metal scales.
Pinch cock.
Pipe prover.
Pipe testing machine.
Plane table.
Planigraph.
Planimeter.
Platen gage.
Platform scale.
Plethysmograph
Pluviameter.
Pluviometrograph.
Pluvioscope.
Pneumatic clock.
Pneumograph.
Pocket level.
Polar clock.
Polariscope.
Polaristrobometer.
Polygonoscope.
Polygraph.
Polyscope.
Polymeter.
Portable scales.
Potassimeter.
Potent.
Powder testing.
Praxinoscope.
Praying wheel.
Pressure gage.
Pressure indicator.
Pressure register.
Printer's rule.
Profilograph.
Proof staff.
Psychometer.
Pulsometer.
Pupillometer.
Pyrheliometer.
Pyrometer.
Quadrant.
Quadrant electrometer.
Radiation thermometer.
Radiometer.
Rails, instru. for measuring wear of.
Railway scale.
Railway speed recorder.
Rain gage.
Range finder.
Ranging rod.
Receiver.
Recoil dynamometer.
Rectal speculum.
Reflecting galvanometer.
Register.
Registering instrument.
Registering scale.
Registering thermometer.
Remontoir.
Reservoir recorder.
Resistance tube.
Resonator.
Respirometer.
Rhinoscope.
Rule.
Rule gage.
Ruling machine.
Saccharometer.
Sacker and weigher.
Salinometer.
Scales.
Scoop, weighing.
Screw and wire gage.
Screw-pitch gage.
Screw thread gage.
Sematrope.
Seismograph.
Seismometer.
Ship's log.
Silk-testing machine.
Siphon recorder.
Siren.
Solar radiation register.
Sondograph.
Sound.
Sounder.
Sounding.
Sounding lead.
Soundings thermometer.
Soundings water cup.
Specific gravity balance.
Specific gravity bottle.
Specific gravity scales.
Specific gravity instruments.
Specific heat apparatus.
Spectrometer.
Spectroscope.
Speculum.

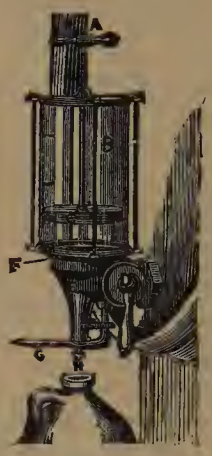
Speed indicator.
Speed measurer.
Speed recorder.
Speed regulator.
Sphereometer.
Sphygmograph.
Sphygmometer.
Sphygmophone.
Sphygmoscope.
Spirophone.
Spring tester.
Spring valve.
Square.
Stadiometer.
Stadium.
Stathmograph.
Station indicator.
Steam engine indicator.
Steam gage.
Steam gage tester.
Step gage.
Stereometer.
Stereoscope.
Stethoscope.
Stethoscopic microphone.
Stock scale.
Stop watch.
Storm glass.
Strain indicator.
Strain measurer.
Straight spring balance
Sugar tester.
Surface plate.
Sympalmograph.
Tachometer.
Tally.
Tally register.
Tannin testing apparatus.
Target, leveling.
Taseometer.
Tasimeter.
Telectroscope.
Telegastograph.
Telegraph.
Telelectroscope.
Telemeter.
Telemicrophone.
Telephone.
Telephone call.
Telephonograph.
Tell-tale compass.
Temperature regulator.
Tension apparatus.
Test gage.
Testing fibers.
Testing machine.
Test plate.
Test spoon.
Thermal alarm.
Thermograph.
Thermometer.
Thermometrograph.
Thermophone.
Thermoscope.
Thermoscopic indicator.
Thermostat.
Thermotelegraph.
Ticket counter.
Ticket punch.
Tidal register.
Tide-calculating machine.
Tide gage.
Time ball.
Time globe.
Time lock.
Toller.
Tonometer.
Topophone.
Torsion balance.
Torsion machine.
Tourbillon.
Tower clock.
Track indicator.
Track scale.
Train-speed indicator.
Transmitter.
Trial jar.
Trial number.
Trigonometer.
Triple telephone.
Tripod head.
Try-square.
Turnstile.
Universal galvanometer.
Universal square.
Urcometer.
Urethrameter.
Urethrometric sound.
Urinometer.
Uroscope.
Uterometric sound.
Velocimeter.
Viameter.
Vino colorimeter.
Viscosimeter.
Visiometer.
Voltameter.
Volumeter
Wall clock.
Watch.
Watch-clock.
Watchman's time detector.
Watch telephone.
Water gage.
Water-level gage.
Water-level indicator.
Water meter.
Weighing machine.
Weighing scale.
Weighing scoop.
Wire gage.
Wire measur'g and cutting m.
Wire measuring machine.
Wire tester.
Yarn assorter.
Yarn meter.
Yarn scale.
Yarn tester.
Zoögyroscope.

Meas'ur-ing. See also : —

The art of, *Siemens* . .	"*Engineering*," xxi. 493.
Extension measuring apparatus, *Willis*, Br. .	* Fig. 991, page 322, *supra*.
Height of clouds, *Matlock*	* "*Scientific American Sup.*," 1482.
Ringwood	* "*Scientific American Sup.*," 1574.
Instruments	* "*Scientific Am. Sup.*," 505, 1638.
Insts., coast survey . .	* "*Scientific American Sup.*," 447.
Jacket, *Lingen* . . .	* "*Scientific Amer.*," xxxix. 295.
Machine	"*Scientific American Sup.*," 389.
Cornell University .	* "*Engineering*," xxi. 396.
	* "*Polytechnic Rev.*," Aug. 5, 1876.
Machine and Gage . .	* "*Min. & Sc. Press*," xxxviii. 305.
Base, triangulation. *Com. Whiting* . . .	* "*Scientific American Sup.*," 2364.
Minute	* "*Man. & Builder*," xii. 134.
Minute of Modern Science, *Mayer*	"*Sc. Am. Sup.*," * 879, 911, * 944, * 975, * 1007, * 1065, * 1135, 1221, * 1274, * 1455, * 1518, * 1595, * 1637, * 1694, 1773, * 2549, * 2625, * 2664, * 2782, * 2810.
In physics, *Spottiswoode*	"*Scientific American Sup.*," 2340.
Stopper, *Keller* . . .	* "*Scientific American*," xxxix. 265.
Standard of	"*Scientific American Sup.*," 2846.
	"*Sc. American*," xxxvii. 372.
Metric system	"*Scientific American*," xl. 393.

Meas'ur-ing Fau'cet. One which shows by means of a graduated vessel of marked quantities, the amount of liquid passing from a tank to a vessel, for instance, or a meter arrangement by which a given quantity is forced through an opening.

Fig. 1697.



Measuring Faucet.

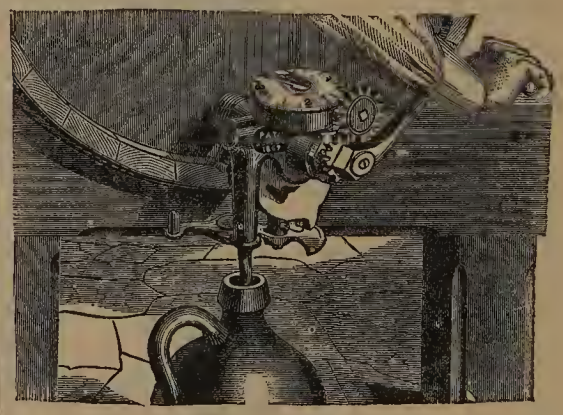
Fig. 1697 is an illustration of the first-mentioned kind; the liquid, being allowed to flow from the barrel into the graduated glass vessel *B*, is forced from the latter by pressure on piston handle *A* at opening *H*, the subsidence of the level in *B* being noticed. *G* is the gate.

Fig. 1698 is a force fed measuring faucet for heavy oils, molasses, etc. The chamber, of known capacity, is emptied at each revolution of the crank, and the pointer on the dial registers the revolutions.

Meat Cut'ter. A meat slicer, for dried beef especially. See BEEF SHAVER, Fig. 256, p. 86, *supra*.

Hittenger's round knife meat cutter has a rotary meat pan and two sets of circular knives that, as the pan rotates, cut the meat. A scraper is attached to the frame by which the sides of the pan are cleared of meat.

Fig. 1698.



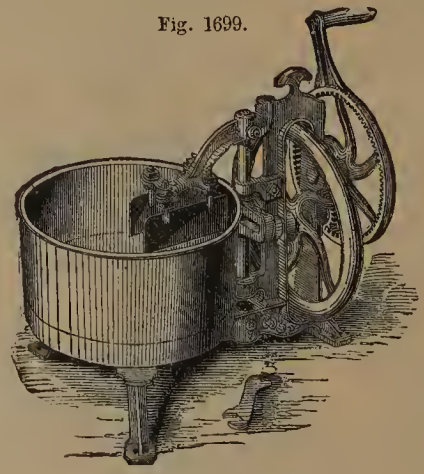
"*Enterprise*" *Measuring Faucet.*

See also forms of machines, Figs. 3106-3110, pp. 1415, 1416, "*Mech. Dict.*" See also SAUSAGE MACHINE, *Ibid.*

Meat Chop'per. A mincing machine for reducing meat to fragments for sausage, hash, or croquettes, salad, pates, etc.

Fig. 1699 is a small-sized machine for the above purposes; also useful chopping fruit and vegetables. The knives are

Fig. 1699.

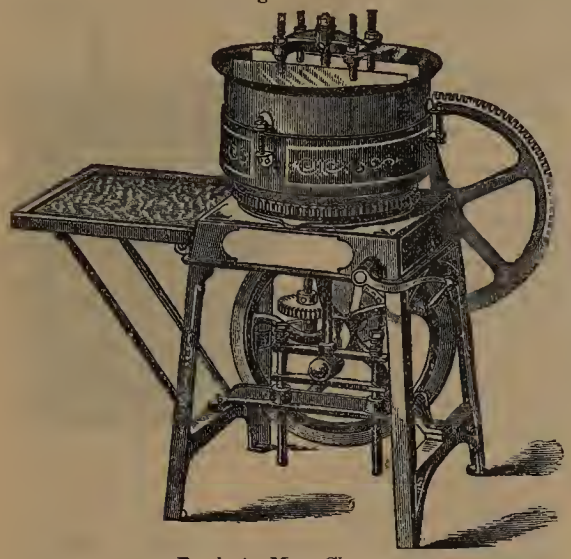


Domestic Meat Chopper

reciprocated vertically with rapidity and the pan turned on its base.

The *Nittinger* meat chopper is on a larger scale, being driven by power, and having automatic turning motion for

Fig. 1700.



Butcher's Meat Chopper.

the pan. The knives are moved vertically by means of an axial rod passing down through the center of the chopping block and attached to a crank-pin beneath. The block has an intermittent motion in the interval between the cuts.

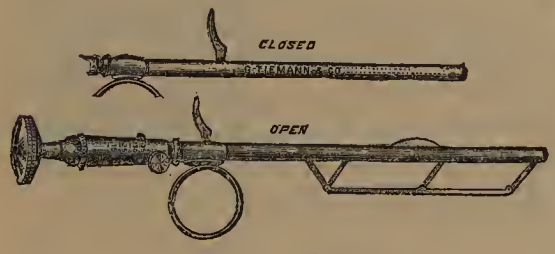
Me-a'to-scope. (*Surgical.*) A speculum for observing a natural passage. Specifically a urethral speculum. The term *endoscope*, from ἔνδον, within, is applied to instruments having a similar purpose.

See Part III., *Tiemann's "Armamentarium."*

Meatoscope, *Weir's*	Fig. 8.
Glass	Fig. 18.
Endoscope, *Désormeaux's*	Fig. 9.
Otis	Fig. 10.
Laveur's	Fig. 11*b*.
Urethral speculum, *Skene's*	Fig. 11.
Folsom's	Fig. 8*b*.

Me-a'to-tome. (*Surgical.*) An instrument to cut open the urethra. Fig. 1701 shows that of Dr. Mitchell, with concealed knife.

Fig. 1701.



Dr. Mitchell's Meatotome.

Gouley's, Fig. 19, Part III., *Tiemann's "Armamentarium."*

Meat Rock'er. A mincing knife having a handle at each end, and worked by a rocking motion.

Fig. 1702.

Meat Rocker.

Me-a'tus In'stru-ments. (*Surgical.*) 1. Instruments for the examination of, or operation on the external meatus auditorius.

Bistoury.	Forceps (see list).
Caustic holder.	Furuncule knife.
Cotton holder.	Marygotome.
Curette.	Otoscope.
Ear hook.	Polypus forceps.
Ear mirror.	Polypus snare.
Ear scoop.	Powder blower.
Ear speculum.	Probe.
Ear syringe.	

2. Instruments for the meatus urinarius. See URETHRAL INSTRUMENTS.

Me-chan'i-cal Bat'te-ry. (*Electricity.*) One in which the plates are moved or shaken to prevent polarization, and to bring them in contact with fresh liquid.

Me-chan'i-cal Ex'er-ci-ser. See EXERCISING MACHINE.

Me-chan'i-cal Fin'ger. (*Microscopy.*) A device used in segregating from a mass of minute material on a slide a minute object, such as a diatom, for instance, and placing it solus upon a slide.

It consists of a wire, bristle, or hair on a stage forceps, the end projecting to the center of the field. The stage is then manipulated by the mechanical movements until the object is beneath the hair. The slide may then be raised by the parabola fixed in the sub-stage so that the minute object becomes attached to the hair. Remove the slide and substitute a clean glass slide, and raise it so as to detach the object from the hair.

Me-chan'i-cal Fir'ing. A mechanical arrangement for the supply of fuel to a furnace.

See * FURNACE FEEDER, Figs. 1116, 1117, p. 363, *supra.*
* PUDDLING FURNACE, *infra.*
* SMOKE-CONSUMING FURNACE, "*Mech. Dict.*"
* "*Scientific American Supplement*," 1218.

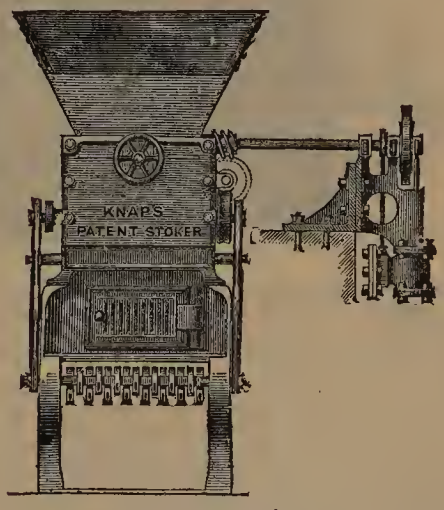
Me-chan'i-cal Print'er. See TYPE WRITER.

Me-chan'i-cal Pud'dler. See PUDDLING FURNACE.

Me-chan'i-cal Sto'ker. An automatic fuel-feeding device for furnace.

That of *Knap*, Br., is shown in Fig. 1703. It consists of a shaft rotated by connection with the engine and having

Fig. 1703.



Mechanical Stoker.

wings in the bottom of the fuel hopper so as to allow an amount of fuel to drop into the furnace, proportioned to the rate of revolution of the shaft and the size of the opening.

Belt connection to a lower shaft gives a periodical lifting to the grate bars so as to disturb clinkers and drop the ashes.

See also Figs. 1116, 1117, p. 363, *supra*; Fig. 5229, p. 2226, "*Mech. Dict.*," "*Sc. Amer. Sup.*," 1423.

Meer'schaum, Ar'ti-fi'cial. The chips and waste of meerschaum pipe making, hardened by pressure.

Gypsum, boiled with stearic acid or paraffiue, much resembles meerschaum. The resemblance may be increased by coloriug the mixture with solution of gamboge and dragon's blood.

"*Scientific American*" . . . . . xxxiv. 383.

Meg-al'o-graphe. A French name for a form of camera-lucida, made by Secretan, of Paris.

It is used for microscopic drawing and pattern drawing for industrial purposes.

It differs from the ordinary camera-lucida, inasmuch as it admits of drawing directly from objects under the microscope, or from designs produced by the turning of the kaleidoscope. It is provided with three tubes one microscopic, one kaleidoscopic, and the third simple. A prism on a detached tube of its own is adjustable to either of these, and by means of mechanical contrivances the point of view may be changed as occasion demands.

"*Scientific American*" . . . . . xxxv. 345.

Meg'a-phone. An instrument for assisting hearing, invented by T. A. Edison.

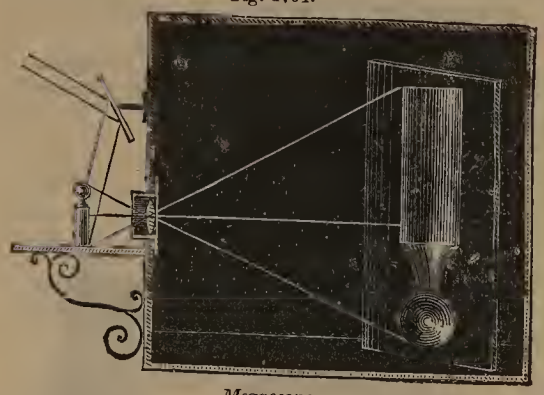
It consists of two large funnels 6′ 8″ long and 27.5″ diameter at the pavilion, with elastic conducting tubes from their apices to the aural orifice. Conversation in moderate tones has been heard and understood at a distance of one and a half miles.

"*Manufacturer and Builder*" . . . . x. 278.
"*Min. and Sc. Press*" . . . . . * xxxvii. 230.
"*Scientific American*" . . . . . * xxxix. 111, 114.
"*Telegraphic Journal*" . . . . . * vi. 297, 383.

Meg'a-scope. A species of camera-obscura for throwing a reflected magnified image upon a screen. In one invented by Dr. Curran, the image is projected by a large compound objective lens 7″ in diameter. The light from the lantern is thrown upon the object itself and is thence reflected to the screen.

In a French form of the instrument, represented in Fig. 1704, especially designed for making enlarged copies of designs, medals, statuettes, and engravings, the instrument consists of a screen, a magnifying lens, a shelf to hold the object, and a mirror to project the light upon the surface presented towards the lens.

Fig. 1704.



Megascope.

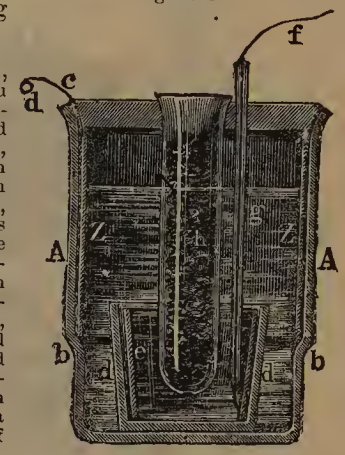
The object is placed on the shelf at such distance from the mirror that the reversed image on the screen shall have the desired size. The image being magnified will have less brilliancy than the object, since the rays reflected from it are spread over a larger surface. To avoid this, the mirror reflecting solar light, or a pair of calcium lights, as used by Dr. Cresson, are employed to illuminate it. The screen is of glass, and the draftsman places himself behind it, and follows with a pencil the lines of the image.

* "*Scientific American*," xxxv. 57.
" *Manufacturer and Builder*," x. 72.
Cresson . . . . . " *Scientific American*," xli. 63.
Morton . . . . . " *Scientific American*," * xxxv. 57.
Knight . . . . . " *English Mechanic*," * xxv. 250.
" *Journal Franklin Institute*."

Me-gass' Dry'er. See Bagasse Dryer.

Mei'din-ger Bat'te-ry. (*Electricity.*) A modification of the Daniell battery, having no porous cell.

Fig. 1705.



Meidinger Battery.

The glass vessel, *A*, has a shoulder, *b*, on which rests the zinc element, *Z*. In *A* is placed a small glass cup, *d*, lined with copper, *e*, on the lower end of which an insulated copper wire, *g*, is riveted. A glass cylinder, *h*, having a hole at the lower end, is suspended from the wooden lid, and contains the sulphate of copper crystals, which keeps the liquid in the cup *d* saturated with that salt. The remainder of the space in vessel *A* is filled with a solution of sulphate of magnesium.

Prescott's "Electricity" . . . . . * p. 53
Sabine . . . . . * 225
Niaudet, Amer. transl. . . . . * 124.

The Meidinger *balloon* battery has a flask magazine for supply of crystals.

Niaudet . . . . . * 127.

Meg-ohm'. (*Electricity.*) A measure of electrical force or resistance equal to 1,000,000 ohms.

Mé-lange'. (*Fabric.*) A French dress goods of cotton chain and woolen weft.

Me-lan'o-scope. Invented by Lommel. It consists of a pair of spectacles, made of two kinds of glass, one on top of the other; the first glass is dark red, the second light violet. This combination admits only red rays, so that all green plants appear black. It may thus be used to recognize the flames of substances which show red lines in the spectroscope, such as potash, strontium, etc.; its use is limited to substances which give red lines.

Me-lan'o-type. A photograph on a background of japanned metallic plate. Invented by Smith & Neff. The name was originated by Peter Neff.

Me-lo'di-o-graph. A contrivance to record the notes of tunes played upon an instrument.

In the melodiograph of Zigliani, a double flat spring placed under each key is connected with a battery and with a recording apparatus, which consists of a comb provided with insulated teeth gently resting on a copper cylinder. A strip of ruled and chemically prepared paper is drawn over this roller by clock-work, and receives the impressions or marks of the teeth of the comb. This clock-work can be regulated so as to cause the paper to move in conformity with the time kept by a person playing the instrument. Every time a key is depressed the circuit is closed, and the electricity, passing through one of the teeth of the comb, makes a mark corresponding to the key that has been depressed.

That of M. Carpentier is described in * "*La Nature*," and the account is reproduced in "*Scientific Canadian*," * x. 106, 107. It was exhibited at the International Exposition of Electricity, Paris, 1881.

The subject has been considered in the "*Mech. Dict.*," Music Writer, p. 1502, where the following instruments are referred to: —

Creed, Br., 1747.
Freke, Br.
Hohlfield, Br.
Hennersdorf, Ger., 1748.
Unger, Ger.

See also Music-recording Instrument, *Ibid.*, same page.

Besides the use of the melodiograph for composers and transcribers of music, the purpose of Carpentier's apparatus is the perforating of sheets for *melophones* and other apparatus for the automatic playing of music. See also "*Scientific American*," xli. 166.

In the apparatus of M. Carpentier the harmonium is one part and the melodiograph another. 50 wires concealed beneath the floor put the two instruments in communication. 50 keys of the harmonium are provided with devices, so that the depression of each makes contact with the corresponding wire. The currents operate a series of perforators, which act upon a band of paper, each one being operated by the

movement of its appropriate key. The band of paper is carried along in the melodiograph by clock-work.

In the use of the perforated paper band for playing, 50 small brushes of silver wire placed in the instrument make contact through the holes with a cross-piece against which they press the paper. When a contact is made by the contact of a brush, through a hole, with the cross-piece, a current circulates in it, operates the opening machine of the corresponding key and causing the reed to speak, sustaining the sound so long as the brush makes its contact through the hole, which may be long or short.

Mel'o-graph. See MELODIOGRAPH.

Melt'ing Fur'nace. (*Glass.*) A furnace in which the *frit* for glass is melted, being then transferred to a *blowing* furnace from which it is worked. This is the better practice. In America it is most frequently worked from the *melting* furnace direct.

Melt'ing Point of Al-loys'. See ALLOYS, "*Mech. Dict.*," p. 66, *et supra.*

Melting points of gold and silver alloys: —

Silver 100 (pure)	954° C.
Silver 80, Gold 20	975
Silver 60, Gold 40	995
Silver 40, Gold 60	1020
Silver 20, Gold 80	1075
Gold 100	1095
Platinum 5, Gold 95	1100
Platinum 25, Gold 75	1225
Platinum 40, Gold 60	1320
Platinum 60, Gold 40	1460
Platinum 80, Gold 20	1600
Platinum 100	1775

"*Annalen der Physik.*"

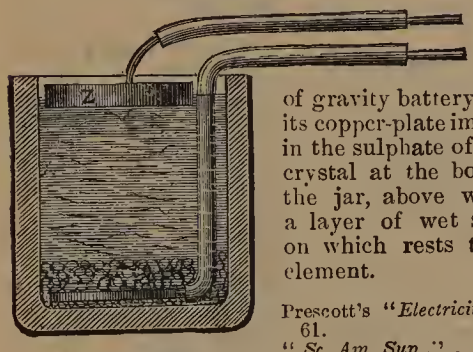
Mem'bra-na Tym-pa'ni In'stru-ments. (*Surgical.*) Instruments for operating on the membrana tympani include: —

Simrock's scissors.	Tympanum perforator.
Eustachian catheter.	Artificial tympanum.
Catheter holder.	Polypus knife.
Meatus knife.	Tensor tympani instrument.
Otoscope.	

See also EAR INSTRUMENTS, p. 289, *supra.*

Me-not'to Bat'ter-y. (*Electricity.*) A form of gravity battery having its copper-plate imbedded in the sulphate of copper crystal at the bottom of the jar, above which is a layer of wet sawdust on which rests the zinc element.

Fig. 1706.



Menotto's Battery.

Prescott's "*Electricity*," * p. 61.
" *Sc. Am. Sup.*," . . * 2513.
Niaudet, "*Am. Transl.*," 111.
"*English Mechanic*" . . . . . xxvii. 506.

Mer'cu-ry. See following references: —

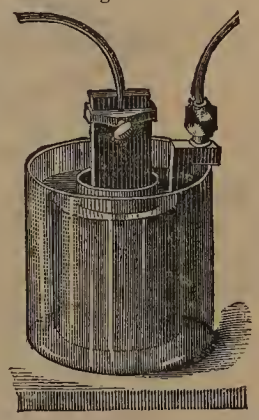
Commutator, *Lartigue*, Fr.	* "*Engineering*," xxvii. 273.
Condenser, *Castle & Long*	* "*Min. & Sc. Press*," xxxv. 209.
Condensers, Cal.	* "*Engineering*," xxviii. 482.
Almaden	* *Laboulaye's* "*Dict.*," ii., ed. 1877, article, "*Mercure*," Figs. 1749-1752.
Furnace, *Berrens*	"*Iron Age*," xxii., Oct. 17, p. 11.
Idria	* *Laboulaye's* "*Dict.*," "*Mercure*," ii., Figs. 1753-1756.
Sarrebrück	* *Laboulaye's* "*Dict.*," "*Mercure*," ii., Figs. 1757-1759.
Obermoschel	* *Laboulaye's* "*Dict.*," "*Mercure*," ii., Figs 1760-1762.
Purification	* "*Sc. Am. Sup.*," 2897
Reduction works, Cal.	* "*Engineering*," xxviii. 403.
Safety valve	* "*Sc. Am. Sup.*," 2193.
Apparatus for testing pressure of; *Teubner*, Ger	* "*Sc Am. Sup.*," 3823.

Its occurrence, mining, smelting, etc. Report of *D. de Cortazar*, "*Centennial Exhibition Reports*," Group I., vol. iii., p. 196.

Mer'cu-ry Bat'te-ry. (*Electricity.*) 1. One having a shallow trough of vulcanite with a partition. On the bottom of each cell is a carbon plate; the zinc is supported a short distance above it, and both submerged in proto-sulphate of mercury. The MARIE-DAVY BATTERY.

2. Another form has the zinc in brine, and the carbon in sulphate of mercury in a porous cup.

Fig. 1707.



Marie-Davy Battery.

"*Ganot's* "*Physics*" (1877), * p. 689.
Sabine's "*Electric Telegraph*," London, 1867, 229.
Beaufils' sulphate of mercury battery has a solid depolarizer "*Telegraphic Journal*" . . . . * vi. 397.
Mercury chromate battery, *Fuller* * "*Sc. Amer. Sup.*," 1127.

Mer'cu-ry Fur'nace. The mercury furnace of M. Hippolyte Berrens, at Barcelona, Spain, is thus described in the "*Correspondance Scientifique*:"

"It consists of a horizontal or vertical furnace, charged periodically, as its action is not continuous. It connects with a transmission chamber, from which the gases pass into condensers, 17 to 25 in number, the shape of which resembles that of two cones united at their base. The lower cone is buried in the ground, the upper, made of sheet iron, is cooled by a continuous stream of water. Each condenser has a capacity of about 30′ cubic. They communicate with one another at their lower parts. The last one of the system is connected with a chamber containing charcoal, destined to remove the last traces of mercury from the gases. There is no chimney, but an aspirator instead, which permits accurate regulation of the furnace. The walls of the apparatus are coated with a layer of a mixture of equal parts of charcoal powder and cement. The furnace at Barcelona was charged with 15,717 pounds of 2.75% ore. Theoretically, therefore, the yield should have been 455.39 pounds of quicksilver, but in fact it was 450.96, which proves a loss of 0.79%, although the carbon of the last receiver was not examined. Gold leaf placed at the end of the apparatus did not show the least trace of amalgam. In a second trial, — made in summer, at a time when work at Almaden is entirely suspended on account of the too heavy loss of quicksilver, — the exhauster was run at so high a speed that the ore in the furnace was glazed; the time of the operation was decreased by 25 hours, and yet the yield from a charge of 15,790 pounds of 2.82% ore was 434.51 pounds, the loss amounting to 3.67%. A horizontal furnace is now building at Anfoudeguilla capable of working 20 to 30 tons of 1% ore per day."

See also references to Mercury furnaces under MERCURY, *supra.*

Mer'cu-ry Hold'er. (*Dentistry.*) A vulcanite cup with cover, for the convenient preparation of amalgam.

Me-rid'i-an Cir'cle. Refer to: —

Fauth & Co.	* "*Scientific American*," xli. 111.
Paris Observatory	* "*Scientific Amer.*," xxxviii. 1, 4.

Laboulaye's "*Dictionnaire des Arts et Manufactures*," iv., ed. 1877, article "*Instruments d'Optique*," * Fig. 33.
Meridian instrument, *Ibid.*, Fig. 29.

Me-ri'no. (*Fabric.*) A fine wool French dress goods woven with a twill on both sides. It is made from 8 to 50 picks to the inch, and is piece-dyed.

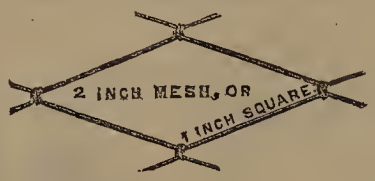
Cashmere resembles it, except in the respect of being twilled on one side only.

Me-ri'no Tulle. (*Fabric.*) An all-wool French goods.

Mesh. The loop in the texture of a net.

The measure is stated by the width of the mesh stick on which it is made; or by the length of one side of the quadrilateral loop. Fig. 1708.

Fig. 1708.



Mesh.

Mesh'ing Net. (*Fishing.*) One which entangles the fish by their gills in the meshes. Seines, and many other nets with specific names, are included with the term *meshing*. See NET.

Mes'sage Cop'y-ing Press. (*Telegraphy.*) A press for taking a copy of a message received before remitting to the sendee.

A duplicate is taken, for filing, by laying a sheet of dampened unsized paper upon the message, and passing the two through a copying press. The latter consists of a pair of rollers, which are turned by steam power, an electro-motor, or by hand, according to circumstances. In large offices, usually by a Phelps electro-motor.

Manifolds are used for press news, of which a large number of copies are required.

Met'al. *Cf.:* —

Alloys, facts about . .	"*Sc. American*," xxxvii. 217.
Coating with oxides . .	"*Scientific American Sup.*," 1672.
Coloring	p. 210, *supra*.
Flow of	* "*Scientific American Sup.*," 1885.
Mining leases, etc., Engl.	"*Scientific American Sup.*," 857.
Packing, *Jackson*, Br. .	* "*Engineering*," xxv. 34.
Preserving compound .	"*Scientific American*," xxxvi. 388.
Protecting	"*Scientific American Sup.*," 1763.

Met'al-ine. A material for the making or the lining of journal boxes. See METALINE, p. 1423, "*Mech. Dict.*," and JOURNAL BOX, p. 1220, *Ibid.*

One analysis gives: —

Paraffine	4.98
Carbon	18.89
Silica	6.44
Lime	3.96
Magnesia	1.90
Ferric-oxide	3.94
Alumina	2.53
Lead	32.40
Zinc	20.07
Tin	1.55
Copper , ... , ...	2.75
Moisture	0.51
	10.01

"*Engineering*" . . . . . xxix. 53
"*Scientific American*" . . . . . xxxiv. 390.

Met'al-ized Glass. An ornamental glass having flakes of gold, platinum, mica, etc., distributed through the glass. It is made by the "Aurora Glass Co.," of London, but much resembles the *Aventurine* (which see), of which it is perhaps but an imitation.

The metals used are principally white and yellow. It is presumed these metals are reduced to powder or thin leaves, and when the article is in process of manufacture the glass is rolled in this metallic dust, which then adheres to the glass, and, by re-heating, the article is finished in the usual way. A piece of broken glass of this variety showed the metals to be near the outer surface and slightly sunk into the glass.

Another mode of working imprisons a metalized surface between two layers of glass.

An object is first blown in glass of the desired color; metallic flakes are then rolled on to it, and a new layer or envelope put on this. The flakes are thus inclosed between two layers of glass. Vases shown in Paris, in 1878, had black interior covered with white mica, others with golden flakes.

Me-tal'lic Chain. The chain of square iron links with clasps. Invented by *Vaucanson*.

Me-tal'lic Pack'ing. Tubes of lead, or some soft metallic alloy, filled with hemp, cotton, or some other suitable vegetable material. These tubes can be prepared of great length and cut to fit any given requirement. The ends may be either soldered together or forced into close contact. The convenience, durability, and cheapness of this packing are especial recommendations. — *Strieder*, "*Dingler's Pol. Jour.*"

Me-tal'lic Shin'gle. A plate of metal with ridges on the face for ornament, and beneath the overlap for joint; a substitute for shingles, tiles, or slate.

Me-tal'li-kon. An English architectural surface decoration for consoles, brackets, casings of pillars, etc.

It consists of ornamental glass, or ceramic slabs, or forms mounted by cement on glass plates which are secured in place. "*Building News*," 1876. "*Scientific American Supplement*," 745.

Me-tal'lo-phone. A keyed instrument with outside resemblance to a piano, but having metallic bars instead of strings. See Fig. 3689, p. 1695, "*Mech. Dict.*"

The subject of musical instruments of percussion possessing bars tuned to a scale is considered under MARIMBA. See also references *passim*.

Met'al-lur'gy. Subjects in Metallurgy are considered under the following heads: —

Aëro-hydric blow-pipe.
Air furnace.
Alloys: —
  Aluminium alloys.
  Aluminium bronze.
  Anti-incrustation alloy.
  Anti-fracture alloy.
  Appliqué.
  Bell-metal.
  Bismuth bronze.
  Brass.
  Bronze.
  Bronze iron.
  Bronze steel.
  Carbon bronze.
  Champ levé.
  Chasing.
  Chromeisen.
  Cloisonné.
  Cock alloy.
  Cupro-manganese.
  Damasceening.
  Damasking.
  Dysiot.
  Electro-silicon.
  Ferro-manganese.
  Ferro-phosphide.
  Ferro-silicium.
  Fusible metals.
  Gold alloy.
  Luhricant alloy.
  Manganese-bronze.
  Manganese copper.
  Metallikon.
  Melting point of alloys.
  Nickel-bronze.
  Phosphor-bronze.
  Phosphide of copper.
  Silver alloy.
  Solder.
  Spence's metal.
  Tungsten-bronze.
  White bronze.
Aluminium.
Aluminium alloys.
Aluminium bronze
Aluminium gun-metal.
Aluminium gold.
Aluminium silver.
Aluminium solder.
Amalgamator.
Amalgam retort.
Amber bronze.
Ammonia-ore process.
Angle-iron.
Anucaling.
Annealing machine
Annular furnace.
Anti-friction metal.
Anti-incrustation alloy.
Antique bronzing.
Appliqué.
Atwood steel.
Axe tempering.
Axle-box metal.
Baron steel.
Basic lining.
Bell.
Bell and hopper.
Bell-metal.
Belly-pipe.
Bérard steel.
Bessemer steel.
Bidiri work.
Billet.
Bismuth alloys.
Bismuth bronze.
Black flux.
Blast furnace.
Blast furnace charger
Blister steel.
Bloom.
Bloomary.
Blowing engine.
Blow-pipe.
Blow-pipe furnace.
Blue bronze.
Bluing.
Brass.
Brass alloys.
Brass black-finish.
Brass blacking.
Brass finishing.
Brass coloring.
Brassing.
Brickhat core.
Bronze.
Bronze blacking.
Bronze casting.
Bronze coloring.
Bronze iron.
Bronze paint.
Bronze steel.
Bronzing.
Browning.
Burning.
Calcining furnace.
Carbon-bronze.
Carbonizing furnace.
Case hardening.
Cast steel.
Catalan forge.
Cementation furnace
Cement steel.
Champ-levé.
Chaplet.
Charcoal core.
Charcoal iron.
Chasing.
Chénot steel.

Chill.
Chromeisen.
Chrome steel.
Cinder notch.
Clappers.
Cloisonné.
Cobalt electro-plating.
Cock alloy.
Coin alloy.
Coke furnace.
Coke oven.
Cold shot.
Cold-shut.
Compressed steel.
Copper.
Copper furnace.
Core.
Cor·ican furnace.
Crucible.
Crucible mold.
Crucible furnace.
Crucible steel.
Cupellation furnace.
Cupola.
Cupro-manganese.
Damasceening.
Damascus steel.
Decomposing furnace.
Deoxydized bronze.
Desilvering lead.
Direct process.
Double shear steel.
Dry-sand core.
Dysiot.
Electric furnace.
Electro-bronzing.
Electro-plating.
Electro-silicon.
Ellerhausen steel.
Emaille.
Euibleuata.
Enamel.
Enameling.
Fagersta steel.
Ferro-chrome.
Ferro-chromium steel.
Ferro-manganese.
Ferro phosphide.
Ferro-silicium.
File tempering.
Fine art metal-working.
Flat chasing.
Flour core.
Foil.
Fore-hearth.
Forge.
Forno-convertisseur.
Foundry furnace.
Foundry ladle.
Frosting.
Furnace : —
Air furnace.
Blast furnace.
Bloomary.
Blow-pipe furnace
Calcining furnace.
Catalan forge.
Cementation furnace.
Coke furnace.
Copper furnace.
Corsican furnace.
Crucible furnace.
Cupellation furnace.
Foundry furnace.
Gas furnace.
Gas-generating furnace.
Gas-producer furnace.
Hot-blast stove.
Heating furnace.
Iron furnace.
Ladle furnace.
Lead furnace.
Mercury furnace.
Open-hearth furnace.
Ore furnace.
Osmium crucible.
Pattinson's pots.
Petroleum furnace.
Ponsard furnace.
Puddling furnace.
Reducing furnace
Refinery.
Regenerator furnace.
Reverberatory.
Roasting furnace.
Shaft furnace.
Siemens furnace.
Siemens-Martin furnace.
Slack-burning gas-furnace.
Smelting furnace.
Steel furnace.
Tempering furnace.
Terrace furnace.
Turf furnace.
Turning furnace.
Washing furnace.
Wind furnace.
Zinc furnace.
Furnace charger.
Furnace door.
Furnace shield.
Fusible metals.
Gazger.
Galvanizing.
Galvanizing furnace.
Galvanizing process.
Gas conductor.
Gas furnace.
Gas-generating furnace.
Gas producer.
Gate.
Gestenhofer furnace.
German silver.
German steel.
Gilding.
Glass furnace.
Glue-water core.
Gold.
Gold alloy.
Gold-colored alloy.
Gold lacquer.
Goldsmith's work.
Gold substitute.
Granulated steel.
Hardening tongs.
Hardness of metals.
Hearth.
Heating furnace.
Heaton steel.
Homogeneous steel.
Hot-blast oven.
Hot-blast stove.
Incrusted bronze.
Incrusted work.
Indian steel.
Inlaying.
Inwall.
Irisation.
Iron.
Iron amalgam.
Iron furnace.
Iron plating.
Iron preserving process.
Iron processes.
Iron steel.
Ivory silvering.
Japanese bronze.
Knobling fire.
Knurling.
Kuft work.
Labyrinth.
Lacquer.
Ladle furnace.
Lead alloys.
Lead-roasting furnace.
Light metal.
Liquid fuel furnace.
Loam and sand core.
Lubricant alloy.
Mackintosh steel.
Malleable bronze.
Malleable iron process.
Manganese bronze.
Manganese copper.
Martin steel.
Matting machine.
Mechanical firing.
Mechanical puddler.
Mechanical stoker.
Mercury furnace.
Metal furnace.
Metaline.
Metallikon.
Melting point of alloys
Metals : —
Alloys (see list).
Aluminium.
Charcoal iron.
Coloring.
Copper.
Gold.
Hardness of metals.
Iron.
Nickel.
Platinum.
Preserving metals.
Tin.
Micolon steel.
Mildew bronze.
Milling.
Molasses-water core.
Molding machine.
Monnier process.
Mosaic gold.
Muck iron.
Mushet steel.
Natural steel.
Nickel.
Nickel-bronze.
Nickel-plating.
Nickel steel.
Niello.
Niello silver.
Nugget.
Open hearth furnace.
Open hearth steel.
Ore breaker.
Ore crusher.
Ore dryer.
Ore furnace.
Ore grinder.
Ore mill.
Ore separator.
Ore sifter.
Ore washer.
Ormolu.
Orugo.
Osmium crucible.
Oxidized silver.
Parcel gilt.
Patina.
Pattinson's kettles.
Pattinson's pots.
Pearl inlaying.
Peat steel.
Pernot steel.
Petroleum furnace.
Phosphide of copper.
Phosphor-bronze.
Phosphor-copper.
Phosphor-tin.
Phosphor-zinc.
Phosphorus steel.
Plating.
Platinizing metals.
Platinum.
Platinum alloy.
Platinum plating.
Ponsard furnace.
Producer.
Puddled steel.
Puddler.
Puddling furnace.
Puddling machine.
Puddling, mechanical.
Quicksilver furnace.
Recuperator.
Reducing furnace.
Reduction process.
Refinery.
Regenerative stove.
Regenerator.
Regenerator furnace.
Repoussé.
Reverberatory.
Riépe steel.
Roasting furnace.
Rosin core.
Rotator.
Rust, preserving iron from.
Salamander.
Satining.
Saw tempering.
Scab.
Scaf.
Scaffold.
Scar.
Semi-steel.
Shaft furnace.
Shaking table.
Shear steel.
Sheet iron.
Sheet lead.
Sideraphthite.
Siemens-Cowper furnace.
Siemens furnace.
Siemens-Martin steel.
Silicon steel.
Silvering.
Silver alloy.
Silver process.
Silver steel.
Silvering iron.
Silver ware.
Single shear steel.
Sintering.
Skewback.
Slack-burning gas-furnace.
Slag.
Slag wool.
Smelting furnace.
Snarling.
Soft-ceuter steel.
Solder.
Soldering.
Soldering furnace.
Soldering iron.
Sour-beer core.
Speigel.
Spelter solder alloys.
Spence's metal.
Spiegel iron.
Spiegeleisen.
Spinning.
Sponge.
Sponge, metallic.
Sponge process.
Spongy platinum.
Sprue hole.
Squeezer.
Staining metals.
Steel : —
Atwood steel.
Baron steel.
Bérard steel.
Bessemer steel.
Blister steel.
Cast steel.
Cement steel.
Chénot steel.
Chromium steel.
Compressed steel.
Crucible steel.
Damascus steel.
Double sheer steel.
Ellerhausen steel.
German steel.
Granulated steel.
Heaton steel.
Indian steel.
Iron steel.
Mackintosh steel.
Martin steel.
Micolon steel.
Mushet steel.
Natural steel.
Open-hearth steel.
Peat steel.
Phosphorus steel.
Puddled steel.
Riépe steel.
Semi-steel.
Shear steel.
Siemens-Martin steel.
Silicon steel.
Silver steel.
Single-shear steel.
Terre-Noire steel.
Tungsten steel.
Uchatius steel.
Vickers steel.
Whitworth steel.
Wootz steel.
Steel chest.
Steel furnace.
Steel-heating furnace.
Steel-iron.
Tasting hole.
Teeming.
Tempering.
Tempering furnace.
Terrace furnace.
Terre-Noire steel.
Tilted steel.
Tin.
Tinfoil.
Tinning metals.
Trommel.
Trompe.
Tula.

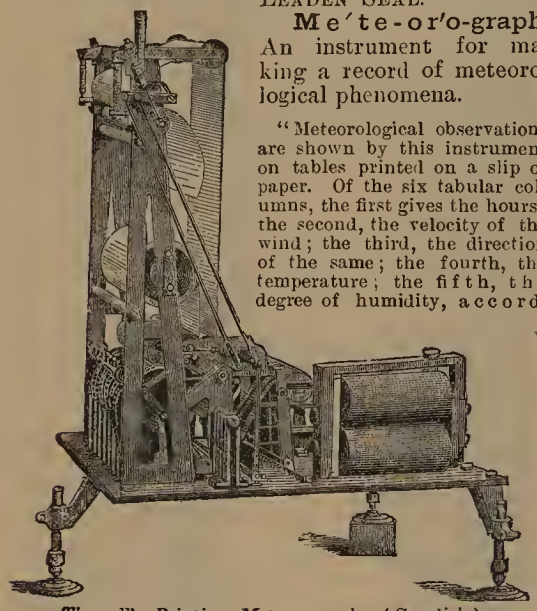
Tulas silver.
Tungsten bronze.
Tungsten steel.
Turf furnace.
Turning furnace.
Tuyere.
Uchatius steel.
Vermeil.
Vickers steel.
Washing furnace.
Water box.
Welding tubes.
White bronze.
Whitworth steel.
Wind furnace.
Wire plating.
Wootz.
Zinc.
Zinc coating.
Zinc coloring.
Zinc furnace.
Zinc plating.
Zinc powder.

Met'al Saw. The band saw — *scierie à ruban* — has been adapted in France and England for cutting thin plates of metal into curved forms, for ornamental or constructive purposes. Such plates form escutcheons, hinges, overlays, and inlays.

Met'al Seal. See LEADEN SEAL.

Me'te-or'o-graph. An instrument for making a record of meteorological phenomena.

Fig. 1709.



Theorell's Printing Meteorograph. (*Swedish.*)

"Meteorological observations are shown by this instrument on tables printed on a slip of paper. Of the six tabular columns, the first gives the hours; the second, the velocity of the wind; the third, the direction of the same; the fourth, the temperature; the fifth, the degree of humidity, according to August's method; and the sixth, the atmospheric pressure, which is given in millimeters. The degrees of the thermometer employed are those of the Centigrade scale, and negative degrees are expressed by their complements of 100. The direction of the wind is indicated by figures from 1 to 32. The numbers expressing the velocity of the wind signify meters in a second.

"The registration takes place by means of electrical currents, which are closed in the barometer and both the thermometers by contact between the quicksilver and steel wires that descend into their tubes, and at the weather-cock and anemometer by contact between a metal knob, which is put into motion by the current, and a wheel which is in a direct mechanical combination with each of these instruments.

"The steel wires in the barometer and in both the thermometers are connected, each by its respective system of brass wheels, with numerical types engraved on the edges, in such a manner that the rotation of the wheels causes an upward or downward motion of the steel wires, so that the point of the scale on which the lower extremity of the wire is situated is necessarily that indicated by the number appearing at the same moment uppermost on the corresponding wheels. The two other brass wheels with engraved figures are likewise combined, by means of electric currents, with the above-named metal knobs in the weather-cock and the anemometer, in such a manner that the figure which is uppermost on the periphery of the wheels at the moment it is about to be registered indicates the direction of the wind at the same moment, and its mean force during the preceding quarter of an hour.

"The wheels containing the figures are governed by an electro-magnetic motor, which for each observation sets the five systems successively in motion until the corresponding wires have reached the quicksilver in the barometer and the two thermometers, and caused a contact between the above-named metal knob in the weather-cock and the anemometer, and the wheels, which are in a mechanical combination with each of these instruments.

"The numbers, therefore, that are uppermost on the numbered wheels are just those which indicate the height of the barometer and of the two thermometers, as well as the direction and velocity of the wind. And now the same electro-magnetic motor operates upon a printing apparatus, which, after having deposited color on the types, presses the above-mentioned slip of paper against them.

"This being done, the steel wires are drawn up again by the motor, which stops as soon as a certain distance from the quicksilver is attained, and all is ready for the next observation. The interval between the observations is a quarter of an hour.

"As the clock which determines the time of the observations does not require winding up, the instrument itself restoring the tension of the mainspring every quarter of an hour, it continues going as long as the impellent force, *i. e.*, the electric current, is maintained; and as the slip of paper applied lasts for fully three months, that is the period for which the instrument may be left to itself." — *M. Sörenson.*

In the meteorological recording instrument of Von Baumhauer, of Utrecht, Holland, shown at the Centennial, the instrument was run by weight and clock-work, the stylus making its marks or dots upon a revolving vertical cylinder with blackened surface.

See also —
Printing, *Theorell*, Sweden . . * "*Sc. Amer. Sup.*," 591.
"*Engineering*," xxvii. 6.
See also ANEMOMETER, *supra.*

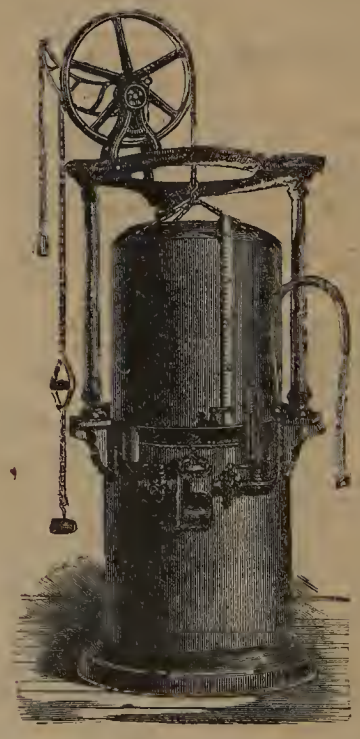
Me'ter. (*Fishing.*) The strengthening line of a seine or gill net, to the upper one of which the floats, and to the lower the weights, are attached. The *seaming* is the marginal line of the net, to which it is seized by meshes, and the *meter* is an outside line seized at intervals of a yard.

Me'ter and Am-mo'ni-a Sat'u-ra'tor. (*Gas.*) An experimental instrument, used in the proving of the quality of gas. — *Goodwin.*

Me'ter Prov'er. (*Gas.*) A holder of known capacity used in testing the accuracy of the indications of a gas meter.

The prover is accurately counterpoised and adjusted so as to give a uniform pressure from top to bottom. The water must be uniform in temperature with the air of the room in which the experiment is conducted. The meter is connected to the holder, and a small quantity admitted to bring the pointer on the index to any figure desired. Next adjust the pointer on the holder to 0°. Turn on the gas and make one or more complete revolutions of the pointer on the dial. The quantity registered by the meter should

Fig. 1710.



Meter Prover.

correspond with the indications on the vertical scale of the holder. Per centage of error is readily calculated.

Met'ric Sys'tem. In addition to the remarks on page 1428, "*Mech. Dict.*," METRIC SYSTEM, in regard to the constitution of the French commission of 1798 to report upon the selection of a natural standard of measurement; and on p. 1554, ODOMETER; p. 173, ASTRONOMICAL INSTRUMENTS, in reference to early measurements in Egypt and Mesopotamia of an arc of the meridian, and by Fernel, physician to Catharine de Medici, 1550: —

Cassini (*b.* 1625; *d.* 1712), the discoverer of the diurnal periods of Jupiter, Mars, Venus, and the Sun; of four satellites of Saturn, of which Huyghens had previously discovered one, and the first observer of zodiacal light, gave great attention to the measurement of an arc of the meridian. Cassini was invited to Paris by Colbert, and he and his descendants of three generations presided over the Observatory of Paris.

President de Brosses, "*En Italie*" (1739), tome i., p. 237, *et seq.* (Didier, Paris, 1858), mentions the church of San Petronio in Bologna and its curiosities: —

"Mais ce qu'il y a de principal est la fameuse ligne méridienne tracée sur le pavé par Cassini, laquelle, tant qu'elle existera, servira de règle aux astronomes à venir pour mesurer l'obliquité de l'écliptique. Elle est ménagée fort adroitment dans la plus grande longeur de l'église, passant avec obliquité entre deux piliers. *La longueur de cette ligne fait la six-cent-millieme partie de la circonference de la terre.*

"Elle est de marbre, devisée dans sa longueur en deux partis égales, par un filet de cuivre qui marque précisement le méridien; et sur le marbre sont gravées toutes les chose qui peuvent avoir rapport à l'ouvrage pour le rendre parfait. L'endroit de la voûte où est le petit trou par où l'image du soleil va se porter à midi préeisément sur la ligne de cuivre s'étant un peu affaissé, on fut obligé, sur la fin du siècle dernier, de restaurer l'ouvrage. Il passe maintenant pour le plus parfait de tous ceux qui sont en ce genre; et ses bonnes qualités sont inscrites sur une pierre inerustée dans le mur. J'ai été choqué de voir qu'on la foulait aux pieds sans respect, ce qu'en efface beaucoup les caractères."

New standard . . . . . "*Sc. Am. Supplement*," 764.
To approx. yards and meters . "*Scientific Am.*," xxxviii. 41.

Me-tror'ga-non. (*Surgical.*) A uterine knife with a guard blade. — *Newman.*

Mex'i-can Bit. (*Manège.*) A stiff cheek bit, having a high port, to which is attached a large ring, which, when the bit is in the horse's mouth, encircles the jaw. The cheeks are long, and have rein rings at the lower ends; they are also wide and quite ornamental; chains and small drops are attached to various parts for the purpose of ornamentation; it is the most severe bit in use.

Mex'i-can Cloth. (*Fabrics.*) A silk and wool French goods.

Mez'za Ma-jol'i-ca. (*Ceramics*) Pottery with a lead glaze and decorated with colors, in which the running together of the glaze and color gives a mingled or softened appearance to the outline of the ornamentation.

The Italian *mezza majolica* of the 15th and 16th centuries was made in great quantity, and some pieces were of great beauty.

It may be said that it preceded the stanniferous glaze (used by the Saracens in Spain and Majorca) and that the secret of the tin glaze was rediscovered by Luca della Robbia, who thus initiated the majolica ware.

Mi'ca. Some of the mechanical and ornamental uses of mica are enumerated on p. 1430, "*Mech. Dict.*"

Spectacle glasses of mica, used in Germany, are concaved in the shape of watch glasses, and are about 1-25″ in thickness. They are mounted in simple brass wire frames, and are made sufficiently large to fit closely around the eye sockets. The advantages gained by this utilization are very great.

Murray's ornamental process for treating mica: —

The mineral is first cut to the desired thickness, then coated with a thin layer of fresh isinglass diluted in water, and tho gold or other surface applied, after which it is allowed to dry. A copper pattern of the desired design is next placed on the reverse side of the sheet, and any superfluous parts of the gilding are removed by means of a small brush, tho design remaining on the parts not brushed. Colors are then laid on as desired, and the whole is coated with a solution of liquid glue, diluted in alcohol. The sheet is then fastened with glue permanently in position

Puscher's process, Nuremberg: Treat thin plates with strong sulphuric acid and then silver as with glass. Cut into shapes for inlaying.

Heat to redness to give a dulled look; for inlaying, —

Scatter powdered mica on sheets of gelatine and varnish.

Mix powdered mica with dissolved gum arabic for a silver paint.

Powdered mica, boiled in hydrochloric acid, washed, and sorted for fineness: used in dusting over artificial flowers, fancy papers, passementerie; articles of wood, metal, glass, paper, papier-maché, gypsum, etc. The articles are painted in bronze colors; then receive a binding coat of gelatine, and the mica is dusted on.

See for colors, etc., BRONZING, p. 138, *supra.*

Dusted over articles coated with asphalt varnish imitates granite.

See also MARBLE, ARTIFICIAL, *supra.*

Mi'co-lon Steel. (*Metallurgy.*) Steel made by the process suggested by Réaumur, 1722, by adding wrought iron to cast iron to reduce the mixture to the proportion of carbon to form steel.

Martin's process is a successful application of the same suggestion.

It may be applied either in the crucible or the cupola. In the former, the proportions of iron and steel are placed in the crucible with such an amount of spiegeleisen as may consist with the character of steel required.

The cupola process, in which coke alone is used as fuel, proceeds in the same way, but the proportions chosen by the inventor have been preferably such as to give a good casting steel for bells, but one which will not weld.

M. Debette thinks "that we have heard the last of this."

Mi'cro-bat'ter-y. A very small galvanic battery, used in testing the delicacy of instruments; as, for instance, a cell of thimble size, with a fraction of a teaspoonful of exciting liquid.

Mr. Collet wrote from Heart's Content, Newfoundland: —

"I have just sent my compliments to Dr. Gould, of Cambridge, who is in Valentia, Ireland, with a battery composed of a gun cap with a strip of zinc, excited by a drop of water the size of a tear."

See also Micro-battery for telephone, "*English Mechanic*," * xxvii. 602.

Mi'cro-far'ad. (*Electricity.*) The millionth part of a farad. The practical unit of capacity; being the trillionth part of the absolute electromagnetic unit $= \frac{1 \text{ volt.}}{10,000}$. — *Gordon.*

Mi-crom'e-ter. (*Microscopy.*) A piece of glass ruled into 100ths and 1000ths of an inch, and used to measure objects in the field.

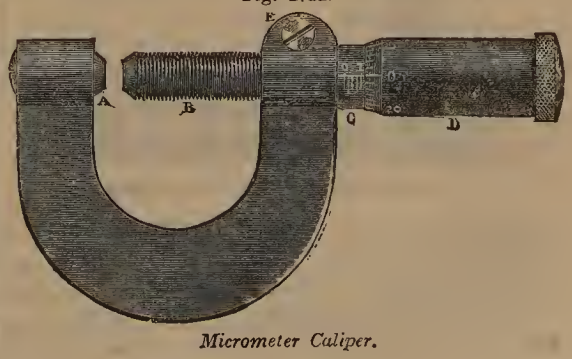
See statement on pp. 1430, 1431, "*Mech. Dict.*"

Cf. *Burch* . . . . . * "*Scientific American Sup.*," 2413.
Davidson . . . . . * "*Mining & Sc. Press*," xxxiv. 265.
Govi . . . . . "*Iron Age*," xxii., Nov. 21, p. 15.
Caliper, *Victor Co.* . . * "*Iron Age*," xxi., Feb. 28, p. 1
Screw, and applications.
Meyer . . . . . * "*Scientific American Sup.*," 911.
Measurements . . . . . * "*Manuf. & Builder*," xi. 14.
Microscope . . . . . * "*Scientific American Sup.*," 1007.

Mi-crom'e-ter Cal'i-per. A pocket instrument for delicate measurements of thickness.

Its range is usually up to 25 millimeters, beyond which the Vernier caliper, Fig. 6968, p. 2707,

Fig. 1711.



Micrometer Caliper.

"*Mech. Dict.*," is regarded as the preferable instrument.

The micrometer caliper is graduated to read to 40ths of millimeters, but 80ths are readily obtained. Binding and adjusting screws furnish ready means for compensating for any wear resulting from use.

The instrument is also made to read in fractions of inches. The one shown has a capacity of 1″, and can be set to ½ and ¼ thousandths.

Mi-crom'e-ter Screw Con'tact Cal'i-per. Mr. A. S. Kimball describes a method used by him to detect the contact of micrometer screws.

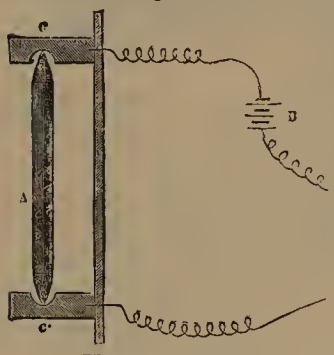
In the case in question the micrometer screw had 60 threads to an inch, and its head was graduated to 300 parts, so that the unit of measurement was the 1-18,000th″. The iron bar, micrometer screw, and a telephone, were put in the circuit of a weak Leclanché cell. When the screw was turned up to loose contact with the bar, the familiar boiling sound of a too sensitive microphone was heard, which ceased the instant firm contact was made, the change to silence being abrupt and sharply defined.

Mi'cro-phone. An instrument which is simply a telephonic transmitter of peculiar form, but which owes its name to the fact that it plays the same part in acoustics in regard to feeble sounds that the microscope does in optics in regard to small objects. It is an amplificator of mechanical vibrations of weak intensity, which it changes into undulatory currents.

Its action depends upon the property possessed by some substances of varying their electrical resistance under varying physical conditions; stress, temperature, division, etc.

The name was given by Mr. Hughes, whose instrument is shown in Fig. 1712, and a view of Ducretet's model is given in Fig. 1713.

Fig. 1712.

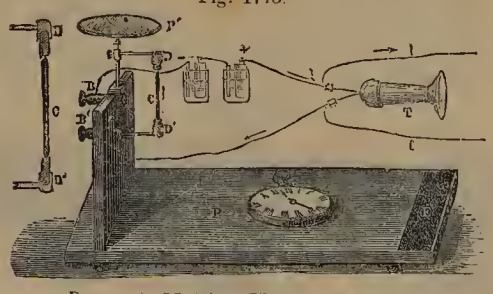


Hughes' Microphone.

"It is formed of a small charcoal crayon, *A*, pointed at both ends. It is lightly held in a vertical position between two cups hollowed out of two small carbon blocks, *C C*, which are fixed to a thin sounding-board. This last is laid on a firm plate. The blocks *C C* are connected by wires with the pile, and the line wire that leads to the telephone.

"Not only words and musical notes, but the faintest vibrations, and even imperceptible sounds, are converted by it into sonorous repetitions. The slightest stroke on or touch against the plate will produce a loud, grating sound in the telephone." — "*Electrician.*"

Fig. 1713.



Ducretet's Model of Hughes' Microphone.

Referring to the question, Hughes *vs.* Edison, *in re* microphone, the "*Electrician*" remarks: —

"It is now easy to understand the slight differences that exist between Edison's carbon transmitter, and the microphone in the simple form given to it by Mr. Hughes.

The telephonic or microphonic action is produced in both instruments by the *variations of electric resistance*, which result from the vibrations that are communicated to the transmitter.

"In Edison's carbon telephone these vibrations act on a plate, that produces variable pressures on a disk. In Hughes' microphone, the vibrations change the points and surface of contact; one is arranged for transmitting words only, while the other is more specially adapted for sending feeble sounds.

"There has been every reason, therefore, from the beginning to consider the inventions of Edison and Hughes as perfectly distinct, both as regards the methods employed, and the effects produced. A whole series of instruments have since bridged over the dividing line between the two original inventions. It is not easy to draw distinctions between the two systems, with the new transmitters of Blake, Boudet, Paris, Ader, etc., before us, but all the microphones and microphonic speakers can be designated under the generic name of *carbon transmitters*."

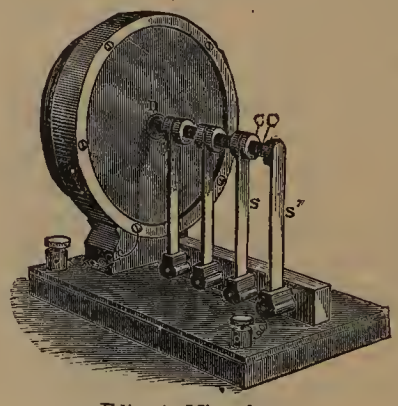
"The small model of a microphone by Ducretet, Fig. 1713, reproduces most of the experiments. A small graphite or coke crayon is pointed at both ends, and kept in a vertical position between two coke carbons, *D D'*. The bearer of the upper cup, *D*, is so arranged that the equilibrium, and the play of the crayon between the cups, can be readily regulated, and consequently the sensitiveness of the microphone. The two cups are in direct communication with the two boundaries, *B B'*. The whole is fixed to a small board and a wooden upright, *P*. Two india rubber tubes, underneath, serve as feet to the board, and isolate any foreign vibrations. A slip of emery paper provides a rough surface, *E*, for producing frictions to be transmitted by the instrument.

"A pile of two or three Daniell or Leclanché elements, and a telephone, *T*, *placed at a distance*, form a complete circuit, in which is comprised the crayon *C*, with imperfect contacts." — "*Electrician.*"

Edison discovered that carbon varied its electrical resistance with variation of pressure, and upon this is based his articulating telephone. Subsequently, this property was found to be inherent in other instances, even the atmospheric medium itself.

Edison's plan was to use several pieces of semi-conductor

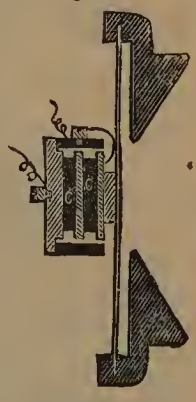
Fig. 1714.



Edison's Microphone.

instead of one. One of his earliest may be seen in Fig 1714. Some pieces of charcoal are supported each by an upright spring. Fig. 1715 has two carbons separated by a plate of metal. Another form has 10 plates of silk prepared by saturation in dextrine and lamp-black. Edison's *pile telephone* has alternate plates of zinc and copper with a bibulous medium between pairs.

Fig. 1715.



Microphone with Carbon disks.

Prescott's "Speaking telephone, Electric light," etc., gives many forms, including the above, and also —

The *condenser*, in which the plates are arranged, as in the ordinary form of condenser.

The *microphone* with graphite rods.

Microphone with pendants.

Microphone without carbon.

The name microtelephone was given by Julian Ockoswicz.

See also STETHOSCOPIC PENDULUM, *infra*.

Coke microphone: Blyth. Articulate sounds can be received, as well as transmitted, by an instrument made of an ordinary earthenware jar, about 8½″ in diameter and 4″ deep, half filled with

PLATE XXIX. BECK'S "INTERNATIONAL" MICROSCOPE. *See page 599*

gas coke broken into coarse fragments. The electrodes are two strips of tin about 2″ wide, slipped down on each side between the pot and the coke, bent over the edges, and fastened with a cord When a pair of these are put in circuit with two strong Grove cells the arrangement is complete. — "*Nature.*"

Pocket microphone: Trouvé. It resembles a small dark lantern, with a carbon crayon substituted. Even when a person speaking stands from 75′ to 100′ from the microphone, it transmits his voice very well to a receiving telephone. The instrument can be used for revealing the movement of a clock, the heart or lungs. — "*La Nature.*"

The instrument is sensitive to the slightest noises in a building: a whisper, a footstep, a creak, mice, the ticks of clock, and what not. A watchman with a most delicate ear.

Pendulum telephone: An upright bar of carbon suspended from a support, so that its lower end rests gently against a sharp contact piece of carbon.

Hughes . . . . . "*Engineering*," * xxv. 370; * 384, 475, 481, 518.
Hughes-Edison . . . "*Engineering*," xxvi. 12, 49.
Receivers . . . . . * "*Engineering*," xxvii. 289.
Sedlaeck, Hungary . . * "*Engineering*," xxviii. 205.
As a seismometer . . "*Engineering*," xxix. 498.
Blyth . . . . . "*Iron Age*," xxii., July 25, p. 7.
Coke . . . . . "*Iron Age*," xxii., Dec. 26, p. 15.
Pocket, *Trouvé*, Fr. . . "*Iron Age*," xxiii., Jan. 9, p. 13.
"*Manuf. & Builder*," x. 151, 195.
Pocket, *Trouvé* . . . * "*Manuf. & Builder*," xi. 63.
In diagnosis . . . . "*Mining & Sc. Press*," xxxvii. 19.
Hughes . . . . . * "*Eng. & Min. Jour.*," xxvi. 186.
Hughes . . . . . * "*Telegraphic Journal*," vi. 225.
Hughes-Edison (by *Pope*) "*Telegraphic Journal*," vi. 300.
Vereker . . . . . * "*Telegraphic Journal*," vi. 312.
Millar (Receiving) . . "*Telegraphic Journal*," vi. 389.
As a seismometer . . . "*Telegraphic Journal*," vii. 68.
Crossley-Hughes . . . * "*Telegraphic Journal*," vii. 144.
Pendulum . . . . . * "*Telegraphic Journal*," vii. 170.
Hughes . . . . . * "*Engineer*," xlv. 343, 405, 461–463.
Lancaster . . . . . * "*Engineer*," xlv. 422.
Barker on . . . . . "*English Mechanic*," xxvii. 517.
du Moncel . . . . . "*English Mechanic*," xxvii. 485.
Microphone . . . . . "*Iron Age*," xxi., June 6, p. 1; June 20, p. 9.
"*Mining & Sc. Press*," xxxvii. 83, 99, 403.
"*Eng. & Min. Jour.*," xxv. 441; * xxvi. 8, 119, 449; xxvii. 77, 129.
* "*Sc. American*," xxxviii. 383, 404; xxxix. 16, 20, 63, * 250.
Hughes . . . . . * "*Eng. Mechanic*," xxvii. 235, 256.
Lancaster . . . . "*Eng. Mechanic*," xxvii. 347, 428.
Microphone pile.
Lancaster . . . . . "*English Mechanic*," xxvii. 343.
Microphone relay.
Houston & Thomson . * "*English Mechanic*," xxvii. 493.
Dowling . . . . . * "*Scientific American*," xl. 324.
Hopkins . . . . . * "*Sc. American*," xxxix. 313.
Stethoscopic . . . . * "*Sc. American*," xxxix. 233.
Tait . . . . . "*Scientific American*," xl. 53.
Hughes . . . . . "*Technologiste*," xl. 198.
As a Teleg. transmitter.
Preece . . . . . "*Journal Soc. Tel. Eng.*," ix. 69.
Ockowicz, on the . . "*Sc. American Sup.*," * 3296.
Muscular contraction . * "*Sc. American Sup.*," 3646.
Receiver, *Millar* . . . * "*Sc. American Sup.*," 2832.
Detecting diffusion of gases through a septum "*Sc. American Sup.*," 2320.
In surgery . . . . . "*Sc. American Sup.*," 2261.
Lancaster . . . . . * "*Sc. American Sup.*," 2183.
Gaiffe-Edison . . . . * "*Sc. American Sup.*," 2187.
Hopkins . . . . . * "*Sc. American Sup.*," 3032.
Preece . . . . . * "*Sc. American Sup.*," 2591.
General résumé . . . * "*Sc. American Sup.*," 2591, 2592.
Modifications, *Hopkins* . * "*Sc. American Sup.*," 2593, 2594.
Simple . . . . . * "*Sc. American Sup.*," 2594.
Stethoscopic . . . . * "*Sc. American Sup.*," 2594.
Musical, *Varley* . . . * "*Sc. American Sup.*," 2594.

Mi′cro-phone Re′lay. A delicate microphone attached to the plate of the receiving telephone as a relay.

As contrived by Houston & Thomson. See "*Telegraphic Journal*," * vi. 343.

The microphone as a relay for itself. * "*Telegraphic Journal*," vi. 361.

Mi′cro-scope. Beck's "International" Microscope, shown in Plate XXIX., has a tripod, *a*, for its base, upon which is placed a revolving fitting *b*, graduated to degrees, by which means the microscope can be turned around without its being lifted from the table, and the amount of such rotation registered; upon this fitting two pillars are firmly fixed, and between them the limb *c* can be elevated or depressed to any angle, and tightened in its position by the lever *d*. The limb carries at one end the body *e* (binocular or monocular), with eye-pieces and object-glasses; in its center is the compound stage *f*, beneath which is the circular plate, sliding on a dove-tailed fitting, and moved up and down by the lever *z*, and carrying the supplementary body or sub-stage *g*; and at the lower end a triangular bar carrying the mirror *h*.

The binocular body consists of two tubes, the one fitted in the optical axis of the microscope, and the other oblique. At their lower end and immediately above the object-glass there is an opening, into which a small brass box or fitting, *i*, slides; this box holds a prism so constructed that when slid in it intercepts half the rays from the object-glass, diverts them from their direct course, and reflects them into the additional or oblique tube. When the box is drawn back to a certain distance the prism in no way interferes with the field of view, and all the rays pass up the direct body, and the microscope is converted into a monocular one.

The upper or eye-piece ends of the tubes are fitted with racks and pinion for varying the distances between the two eye-pieces, to suit the differences between the eyes of various persons.

This body is moved up and down with a quick movement by means of the milled heads *k*, and with a very delicate and fine adjustment by the milled head *l*.

The compound stage is of new construction; the object is most frequently merely placed upon it, but, if necessary, it can be clamped by carefully bringing down the spring-piece *m*; the ledge will slide up or down, and the object may be pushed sideways; this arrangement forms the coarse adjustment. Finer movements in vertical and horizontal directions are effected by means of two milled heads, *n* and *o*. The whole stage revolves in a circular ring by the milled head *p*, or this can be drawn out, and then it turns rapidly by merely applying the fingers to the two ivory studs *q q* fastened on the top plate, which is divided into degrees to register the amount of revolution. The stage is attached to the limb on a pivot, and can be rotated to any angle, which angle is recorded on the divided plate *r*, or can be turned completely over, so that the object can be viewed by light of any obliquity without any interference from the thickness of the stage.

Beneath and attached to the stage is an iris diaphragm, *s*, which can be altogether removed, as shown in the illustration, from its dove-tailed fitting, so as not to interfere during the rotation of the stage. The variations in the aperture of this diaphragm are made by a pinion working into a racked arc and adjusted by the milled head *t*.

Beneath the stage are two triangular bars, *u v*, the one revolving around and the other rigid in the optical axis of the instrument. On the former the sub-stage *g*, carrying all the apparatus for illumination and polarization, fits, and is racked up and down by the milled head *w*; the mirror also, if desired, slides on the same bar; the revolving motion to this bar is given by the milled head *x*, and the amount of angular movement is recorded on the circle *y*, while the whole of this part of the stand is raised and lowered concentric with the optical axis of the instrument by the lever *z*, and the amount of such elevation or depression registered on a scale attached to the limb. This bar can be carried around and above the stage and be thus used for opaque illumination.

The lower triangular bar *v* carries the mirror *h*, or a right-angle prism, when the illumination is required to be concentric with the optical axis of the instrument, and independent of the movements of other illuminating apparatus.

The mirror-box contains two mirrors, one flat and the other concave; it swings in a rotating semicircle attached to a lengthening bar, which enables it to be turned from one side to the other, and revolves on a circular fitting for giving greater facilities in regulating the direction of the beam of light reflected, the whole sliding on either of the triangular bars, and made to reverse in the socket so as to bring the center of the mirror concentric with the axis of the microscope in either case.

As the mirror alone is insufficient for many kinds of illumination, some provision has to be made for holding various pieces of apparatus between the object and the mirror. For this purpose a supplementary body, or sub-stage, *g*, is mounted perfectly true with the body, and is moved up and down in its fitting by rack and pinion connected with the milled heads *w*. This sub-stage is now regarded as one of the most important parts of the achromatic microscope; in it all the varied appliances for modifying the character and

direction of the light are fitted. But a few years since it was considered sufficient for this part of the stand to be constructed so as to move up and down perfectly coincident with the optical axis of the instrument, and for that purpose it was racked in a groove planed out on the same limb as that on the upper end of which the optical portions were carried. But lately microscopists have shown the desirability of affording every facility for lateral angular adjustments; and this has led to the sub-stage being attached to an arc working in the circular plate *y*, and moved by a rack and pinion, *x*, while the amount of such angular movement is recorded on the upper surface of the plate *y*. Having once fixed the angular direction of the light, the focusing of it depends upon the lever *z*, which moves the circle up and down, and with it the arm carrying the illuminating apparatus, *in the optical axis of the instrument.*

See Microscopy, *Gulliver* "*Scientific American Sup.*," 1494.
Microscope, *Waechter* . * "*Scientific American Sup.*," 4139.
Attachment, *Woodward* * "*Scientific American Sup.*," 1482.
Binocular, *Taylor* . . * "*Scientific American Sup.*," 1496.
Cheap . . . . . * "*Scientific American*," xxxiv. 37.
In chemistry, *Sorby* . . "*Scientific American Sup.*," 1976.
Drawing apparatus . . "*Scientific American Sup.*," 440.
Exhibition of . . . . "*Scientific American*," xxxvi. 209.
Galileo's . . . . . * "*Scientific American Sup.*," 742.
Gas . . . . . * "*Scientific American*," xxxv. 328.
Home-made, *Hichels* . . * "*Pop. Science Mon.*," Nov., 1875.
Images on screen . . * "*Scientific Amer.*," xxxiv. 101.
Janssen's . . . . . * "*Scientific American Sup.*," 727.
Leewenhoeck's . . . . * "*Scientific American Sup.*," 727.
Life slide, *Holman* . . "*Scientific American Sup.*," 1650.
Musschenbroeck's . . . * "*Scientific American Sup.*," 727.
Objective, Russian, 32″ "*Sc. Am.*," xxxvi. 273; xli. 249.
Object-finder, *Bardeen* . * "*Scientific Amer.*," xxxvi. 100.
Slide, *Broeck* . . . . * "*Scientific American Sup.*," 510.
Test plates, *Roger's* . . "*Scientific American*," xxxv. 154.
Vision, *Stephenson* . . * "*Scientific American Sup.*," 1288.

Gosse's "Evenings at the Microscope."

Micro-photog., *Roch* . . "*Scientific Am. Sup.*," 1324, 4139.
Microscopic photography "*Scientific Amer.*," xxxvi. 226.

Mi'cro-scope Il-lu'mi-na'tor. (*Optics.*) A convenient form of lamp adapted to the use of the microscope. The metallic chimney is telescopic, the condenser fits into the cell in front. The reservoir is of brass. The lamp slides vertically on a pillar, and may be inclined to direct the rays. The chimney is lined with gypsum.

Fig. 1716.

Microscopic Illuminator.

Mi'cro-scope Lamp. (*Optics.*) A lamp for convenient use with the microscope. Several have been invented, the great desiderata being: —

1. Ease of elevation or depression of the lamp by attachment to a long upright rod.
2. A flat wick, so as by turning either the edge or broadside of the flame to get intensity or volume.
3. Absence of great heat.

In a special form of lamp, on a bull's-eye stand, the lamp is attached to a bull's-eye lens, the position of which can be varied at pleasure for varying the character and direction of the rays.

Mi'cro-scope Ta'ble. (*Optics.*) A pillar and claw table, employed in connection with the microscope which stands upon it.

The top is mounted on a strong iron center which enables the observer to revolve the microscope at pleasure without vibration.

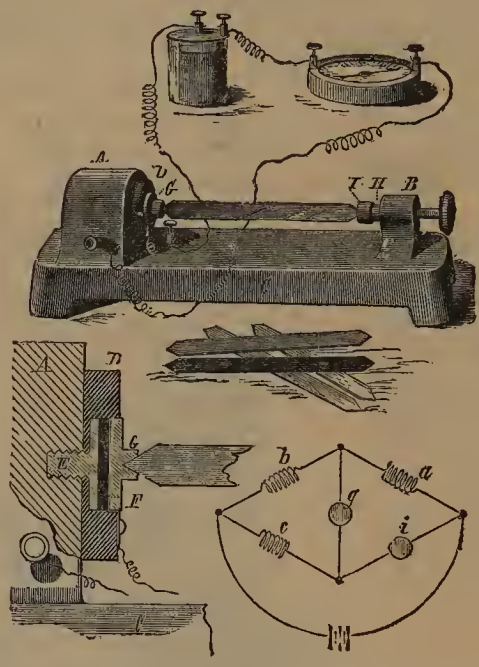
Mi'cro-spec'tro-scope. (*Optics.*) See Spectroscopic Eye-piece.

Mi'cro-ta-sim'e-ter. An instrument, by Edison, for the detection and measurement of infinitesimal pressure. The instrument consists essentially of a rigid iron frame for holding a carbon button, which is placed between two platinum surfaces, one of which is fixed and the other movable, and in a device for holding the object to be tested so that the pressure resulting from the expansion of the object acts upon the carbon button.

The instrument is represented in Fig. 1717 by perspective, sectional, and plan views.

A B are posts rising from plate *C*. To post *A* a vulcanite disk is attached by the platinum-headed screw *E*, which rests in a cavity in the disk. On the head of the screw is the carbon button *F*, and upon its outer face is a disk of platinum foil which is in electrical communication with the battery. A metallic cap, *G*, receives one end of the bar to be tested, the other end being in a cup, *I*, on the end of a screw, *H*, on the other head, *B*. The post *A* is in connection with a galvanometer, in turn connected with the battery. After the strip has been subjected to a small initial pressure, which deflects the needle of the galvanometer, the slightest expansion or contraction of the strip will be indicated by the needle. The warmth of the hand held a few inches from a hard rubber strip caused an expansion which was indicated by a deflection of a few degrees of an ordinary galvanometer, which was not affected in the slightest degree by a thermopile facing and near a red-hot iron. The principle of this apparatus is to be applied to delicate thermometers, barometers, and hygrometers.

Fig. 1717.



Edison's Microtasimeter.

Fig. 1718 shows the apparatus as constructed for more delicate operations. The instrument is connected with a Thomson's reflecting galvanometer, and the current is regulated by a Wheatstone's bridge and a rheostat, so that the resistance on both sides of the galvanometer is equal, and the light pencil from the reflector falls on 0° of the scale. The principle is illustrated in the plan view in Fig. 1717, where *g* is the galvanometer, *i* the instrument. At *a b c* the resistance is the same. An increase or diminution of the pressure on the carbon button by an infinitesimal expansion or contraction of the substance under test is indicated on the scale of the galvanometer.

The carbon button may be compared to a valve, for, when it is compressed in the slightest degree, its electrical conductivity is increased, and when it is allowed to expand it partly loses its conducting power.

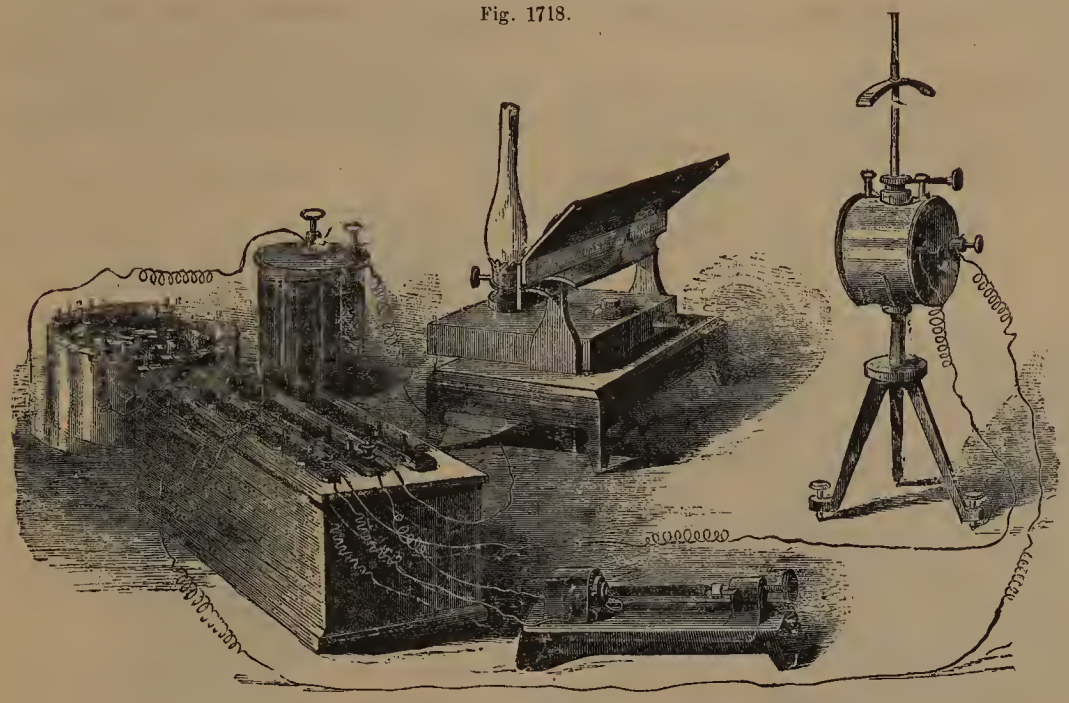
The heat from the hand, held 6″ or 8″ from a strip of vulcanite placed in the instrument — when arranged as last described — is sufficient to deflect the galvanometer mirror so as to throw the light-beam completely off the scale. A cold body placed near the vulcanite strip will carry the light-beam in the opposite direction.

Pressure that is inappreciable and undiscoverable by other means is distinctly indicated by this instrument.

See also Tasimeter, *infra.*

Cf. "*Eng. & Mining Journal*" . . . * xxvi. 186.
"*Engineering*" . . . . . * xxvi. 99.
"*Iron Age*" . . . . . xxi., June 20, p. 15.
"*Telegraphic Journal*" . . . . * vi. 314; * vi. 458.

Fig. 1718.

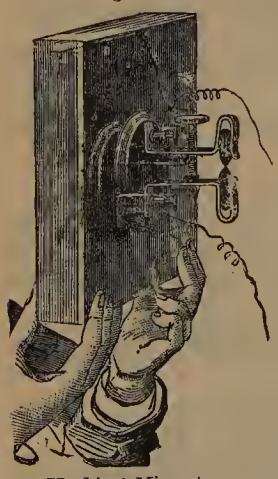


Microtasimeter with Reflecting Galvanometer.

"*English Mechanic*" . . . . . * xxvii. 414.
"*Scientific American*" . . . . . * xxxviii. 385.
"*Engineer*," *Edison* . . . . . * xlvi. 99.
"*Tasimeter*" . . . . . * xlvi., Fig. 3, 425.
"*Journal Society Telegraphic Eng.*" . * vii. 379.

Mi'cro-tel'e-phone. The name given by its inventor, Julian Ockovowicz, of Lemberg, Gallicia, ("*Telegraphic Journal*," vii. 132) to a Bell telephone in which the current generated by the vibration of the diaphragm is caused to pass through the diaphragm as well as the core before it enters the line.

Fig. 1719.



Hopkins' Microphone.

The communication of the current with the vibrating plate is effected by means of two small springs which are lightly pressed by the membrane, and which act as a microphonic contact. 3 mm. above the iron diaphragm is a membrane of caoutchouc, so that the two inclose a film of air between them.

Dr. Hopkins' instrument consists essentially of two springs secured to a small base piece, and each supporting at their upper end a piece of ordinary battery carbon. These two pieces of carbon are placed in light contact, and the two springs are put in an electrical circuit in which there is also a receiving telephone of the Bell form. In Fig. 1719 it is shown as secured to a small sounding-board. The two carbon supporting springs are fastened to a single base by the binding posts which receive the battery wires. An adjusting screw passes through one of the springs at or near its center, and bears against a rubber button projecting from the other spring. This simple device when placed on a table indicates in the receiving telephone the slightest touch of the finger on the table or on the instrument. Blowing on it makes in the receiving instrument a deafening roar; drawing a hair or a bit of cotton across the carbon is distinctly audible in the receiving instrument.

Cf. . . . . * "*Iron Age*," xxii., Sept. 26, p. 15.
"*English Mechanic*," xxvii. 511.
"*Scientific Amer.*," xxxix. 170.
Trouvé . . . . . * "*Scientific Amer. Sup.*," 2481.
Hopkins . . . . . * "*Scientific Amer. Sup.*," 2693.
Theory of . . . . . "*Scientific American Sup.*," 3806.
Lucdtge . . . . . "*Scientific American Sup.*," 3078.

Refer to CARBON TELEPHONE, Fig. 535, p. 165, *supra*.

Mi'cro'tome. An instrument for cutting very thin sections of soft substances for microscopic purposes.

* "*Sc. Am. Sup.*," 1321.
Rivet . . . * "*English Mechanic*," 8.

Mid'dlings. (*Milling.*) Coarse particles of the kernel from immediately adjoining the skin of the berry, and now appreciated as the most valuable part because consisting largely of *gluten*, while the interior of the kernel is composed of the *starch*, which, when dry, readily becomes a pearly powder.

Under the method of *straight grinding* almost universally practiced until within a very few years, the prime object of the miller was to make as few middlings as possible, considering them only fit to be ground into an inferior grade of flour, or high grade of feed. Consequently the grinding was done very *close* with keen, sharp burrs; shaving into powder as far as practicable all this compact horny part of the kernel, which thus became incorporated with the interior or starchy part, and through the bolt was separated from the bran or skin of the berry. The coarser particles, known as middlings, remained mixed with small particles of bran and other foreign substances, also a fine fuzz, which is found on the skin of the berry.

The new process consists in manufacturing a flour out of the middlings, having larger and more uniform granules than the flour which is made from the central part of the berry, and free from the fine impurities mixed with the first grinding.

The middlings are passed through a machine called a purifier, so arranged that a properly regulated current of air may be sucked or driven through them, separating all the fuzz and small specks, which have less weight than the particles of the kernel thus freed of impurities. The purified middlings are then reground, with care, so that the grinding may be even and the angular shape of the particles retained. After grinding, it is bolted as usual through proper numbers of cloth, and the larger particles passing over the tail of the reel are returned to the purifier and stone.

This is a general synopsis of the process, which is of course varied to suit the judgment and experience of skilled millers, some using many purifiers for frequent separations and different methods of manipulating the returns and re-grinding.

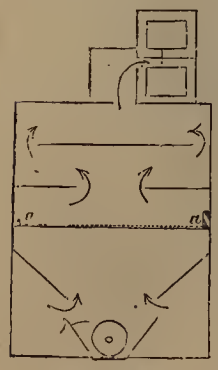
The middlings flour being sought after as superior to the straight grade, it is desirable to *grind high*, and make as much middlings as practicable, — frequently 35 to 40% is made into middlings flour.

See also HIGH MILLING, p. 458, *supra*; and references *passim*.

Mid'dlings Pu'ri-fi'er. The separation of middlings by air currents and by shaking are old devices.

The employment of the hand sieve and natural current of air, as in the ancient mode of winnowing (Fig. 7256, p. 2786, "*Mech. Dict.*"), but on a smaller scale and in more confined situation, was the natural resource before reels and bolting chests came into use. The middlings purifier proper is something more than a mere bolt; properly speaking, it is a machine for separating minute bran scales from grits by causing a broad stream of air either by blast or suction, to pass through a slightly-inclined plane sieve of meshes sufficiently large for both the bran and grits to pass through; the force of the blast being so gentle as to permit the grits to drop, while the particles of bran are kept afloat to be discharged at the lower margin of the sieve. The sieve is sometimes disposed around a cylinder, and the action promoted by a brush acting upon the surface of the sieve in connection with the blast or suction. Of this class, several of most ingenious construction, under the name of middlings-purifiers, have been recently invented and brought into use in this country.

Fig. 1720.



Principle of Middling Purifier

The accompanying figure illustrates one of the simpler forms.

a a, is the slightly-inclined sieve, through which the air is carried upward by the exhaust-fan, by which the fine bran is prevented from passing through, while the heavier grits are dropped to the trough below.

The subject has been considered on pp. 1436, 1437, "*Mech. Dict.*," where the machines of

* *Lacroix*,
* *Smith*,
* *Mowry*,
* *Huntley & Holcomb*,
* *Wilson*,

have been adduced as illustrating five modes, having certain points of difference in operation.

Several systems of grading middlings and bolting are described in *Rollet's* French work on milling (Paris, 1847), including those of

* *Lanturelu*,
* *Benoist*.

Reference is made to the above also in "*Scientific American Supplement*," where are also shown the apparatus of

* *Westrupp*, Br., 1854.
* *Perrigault*, Fr., 1862.
* *Cabanes*, Fr., 1855.

A slight, general sketch of the distinctive methods may be given, and reference for particulars can be made to the publications cited in the subsequent list: —

La Croix's device consists in the combination with the reciprocating screens of traveling air tubes under the screen placed 5″ on centers, and moving backward and forward 5″. These tubes are supplied with air at high pressure by means of two small but powerful blast fans. The air is discharged in thin sheets the entire width of the cloth, which cleans the meshes, and raises the light fibrous matter from the middlings so that it may be readily drawn off by the suction fan, which is employed on top of the machine as usual.

Walker. A distributing feed shoe; an inclined, shaking, suction blast separator suspended and vibrated upon links, and divided into sections, each of which consists of a series of slightly inclined shelves, extending to the side-boards of the suspended separator; a brush and concave arrest the middlings at their mid-passage, and they fall upon a shaking sieve where they are sorted and certain portions returned for re-dressing.

Collin's "Garden City." A succession of inclined sieves of gradually coarser quality, and suction blast of increasing strength in the descending order. The matter passing through each sieve is spouted away to its own receptacle.

Smith. Has feeding rollers, shaking bolt, traveling brushes to clean meshes of the cloth, and upward current of air to carry off impurities.

Reel & Seyler "Champion." Has a spout and rotary reel for separating the finer particles; thence to a chute where the fuzz is withdrawn by a suction fan; then to a series of grading sieves with upward blast.

Huntley, Holcomb, & Heine "Excelsior." Middlings are fed through tubes to disintegrators, two in succession; the dust and fiber are carried off through wind-trunk, and go to a feed hopper and reel to be sorted; the middlings pass to shaking sieves with upward draft.

Hunter. A blast machine with percussion sieve.

"Phœnix" has suction fan, sloped sieves, and a succession of hoppers for graded product.

"Keystone." Succession of zigzag inclined sieves and suction draft.

Affleck. The middlings are subjected to a current of air before going on to the sieve, where the purification is finished and the floury matter drawn off into a suitable bolt.

Cochrane's patent, of so much interest in regard to the suits at law in this matter, is No. 37,318, January 6, 1863. See "*American Miller*," vi. 11.

Refer to — *Bauer* . . . * "*American Miller*," iv. 101.
Benoist . . . . . * "*Scientific Amer. Sup.*," * 1602.
Buehlmann . . . . * "*American Miller*," v. 181.
Cabanes . . . . . * "*Scientific Amer. Sup.*," * 1602.
Cabanes, Purifier . . * "*American Miller*," v. 197.
Case . . . . . * "*American Miller*," viii. 370.
"Champion" . . . * "*American Miller*," v. 55.
Cochran (Patent No. 37,318, Jan. 6, 1863.) * "*American Miller*," vi. 11.
Collins, "Garden City" * "*American Miller*," iv. 89.
Currier, Mill . . . . * "*American Miller*," vii. 267.
* "*American Miller*," viii. 29.
Dell, Br. . . . . * "*Engineer*," xlvi. 403.
Downton . . . . . * "*American Miller*," vi. 21.
Electric . . . . . "*Scientific American*," xlii. 209.
Elwell, Separator . . * "*Scientific American*," xxxiv. 342.
* "*Scientific Amer.*," xxxix. 166.
Fender, "Standard . * "*American Miller*," v. 83.
"Garden City" . . * "*American Miller*," v. 69.
"Helvetia" . . . . * "*American Miller*," viii. 157.
Hunter . . . . . * "*American Miller*," vi. 21.
Huntley, "Excelsior" * "*American Miller*," iv. 137.
Jones, "Paragon" . * "*American Miller*," iv. 93.
Keller . . . . . * "*American Miller*," viii. 315.
Lacroix . . . . . * "*American Miller*," v. 83.
* "*American Miller*," vii. 103, 266.
Lanturelu . . . . * "*Scientific Amer. Sup.*," * 1602.
Millot, Switz. . . . * "*Engineer*," xlvi. 258.
Ohio Midd. Purif. Co. * "*American Miller*," iv. 90.
Osborne . . . . . * "*Scientific American Sup.*," 3744.
"Paragon" . . . . * "*Scientific American Sup.*," 431.
* "*American Miller*," iv. 37.
Perrigault . . . . * "*Scientific Amer. Sup.*," * 1602.
Pyne . . . . . * "*American Miller*," vii. 338.
Redfield . . . . . * "*American Miller*," viii. 3.
Reel, "Champion" . * "*American Miller*," v. 55.
Smith . . . . . * "*American Miller*," iv. 140.
Schoonover . . . . * "*American Miller*," viii. 29.
Suits, arguments . . * "*American Miller*," vii. 70.
"Summit" . . . . * "*American Miller*," viii. 315.
Sutcliffe . . . . . * "*Engineer*," xli. 391.
* "*American Miller*," v. 72.
Walworth, Br. . . . * "*Engineer*," xliii. 415.
Westropp . . . . . * "*Scientific Amer. Sup.*," 1602.
Wolf . . . . . * "*American Miller*," viii. 183.

Mid'ship-man's Hitch. (*Nautical.*) A kind of hitch shown at *i*, Fig. 2513, p. 1105, "*Mech. Dict.*"

Mil'dew Bronze. An imitation of the *patina* or surface effect obtained by lapse of ages and exposure of ancient bronzes.

Dissolve equal weights of nitrate of iron and hyposulphite of soda in eight parts of water; immerse the articles in this until of the right tint, then well wash with water, dry, and brush: one part chloride of iron and two parts water imparts to brass a fine autique green. Brush well and lacquer with pale gold lacquer, or polish with oil.

Mil'i-um Nee'dle. (*Surgical.*) A fine needle with curved hastate point used in skin grafting. — *Piffard.*

Milk. See the following references: —

Analysis apparatus.
Von Baumhauer . * "*Scientific American Sup.*," 1162.
Condensed . . . . . * "*Scientific American Sup.*," 2482.
Cooler, Austrian . . . * "*Scientific American*," xl. 292.
Milking apparatus
Blurton, Engl. . . . * "*Scientific American Sup.*," 2346.
Milker, *Mollen* . . . * "*Scientific American*," xxxvi. 102.
Skimmer, centrifugal.
Wannieck, Austrian . * "*Engineering*," xxviii. 21.
Stool and strainer.
Valentine . . . . . * "*Scientific American*," xlii. 100.
Milk sugar manufacture "*Scientific American*," xxxvi. 56.

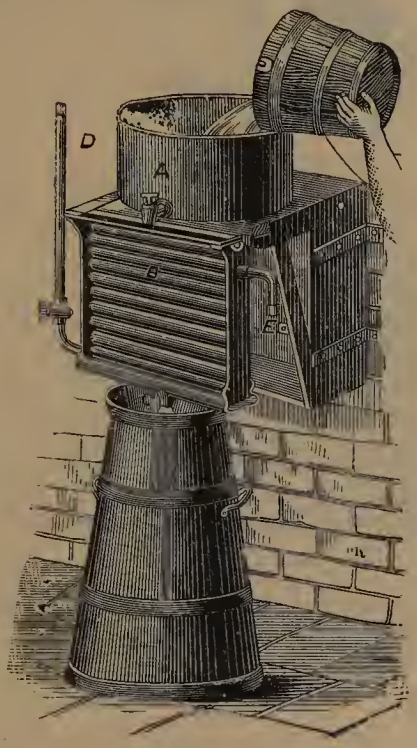
See LACTOMETER, LACTODENSIMETER, GALACTOMETER; PIOSCOPE; CREAMERY, CHEESE, CHURN, etc., and references *passim*.

Milk Car. (*Railway.*) One for carrying milk in cans. It is usually made with end platforms like a baggage car, and has the springs of a passenger car. — *Forney.*

Milk Cool'er. An apparatus for removing the natural warmth of fresh milk. Two forms are shown.

Fig. 1721 is Lawrence's capillary refrigerator (Br.), which is also adapted to cooling wort. Milk as soon as milked is poured into the strainer *A*, whence it passes into a chamber

Fig. 1721.

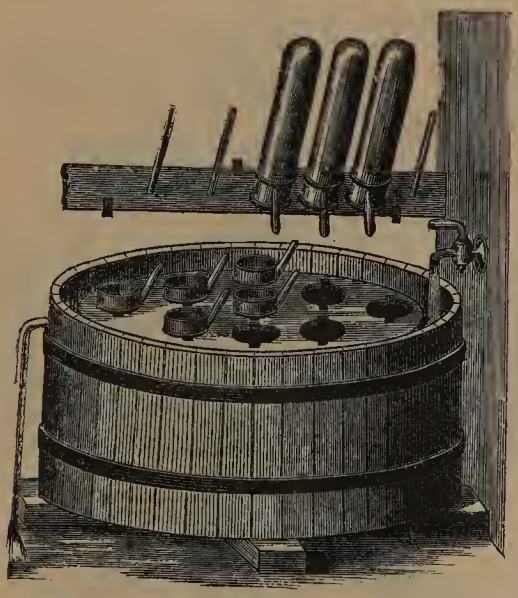


British Milk Cooler.

which is occupied by a system of convoluted pipes, *B*, in which cold water circulates, passing by pipe *D* to *E*, and exit. The milk flows into the churn *C*. The front end of the cooler chamber is removed to expose the interior.

The Austrian cooler, Fig. 1722, is very simple, and consists of a vat or tub through which cold water is constantly circulating. On the surface of the water floats a circular

Fig. 1722.



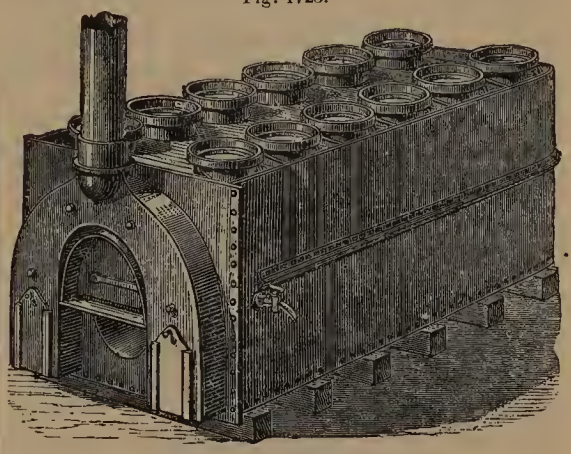
Vienna Milk Cooler.

wooden plate, provided with a number of round holes into which are inserted the vessels containing the milk. These are made of sheet zinc, two feet long, and each, according to the "*Wiener Landw. Zeitung*," contains a little over a gallon of milk.

It takes about fifteen minutes to cool the milk down to a temperature slightly above that of the surrounding water. When not in use the cylinders are turned upside down on a wooden rack to drain and dry.

Milk Glass. A semi-translucent glass used in some graduated glass instruments to contain the scale in order to render it more legible. See also Cryolite; Hot Cast Porcelain, etc.

Fig. 1723.



French Milk Heater.

Milk Heat'er. (*Dairy.*) A furnace arrangement for heating milk for cheese-making.

That shown in Fig. 1723 is a French form in which the deep cans set in a water bath above a furnace. The furnace and tank are of sheet iron.

See also Milk Pan.

Fig. 1724.

Milking Tube.

Milk'ing Tube. A tube inserted into the via lactea of a cow's teat in order to overcome the muscular contraction and allow the milk to flow without the use of the hands. The tubes are of silver, four to a set, and are telescopic to suit varying lengths of teats.

Milk Pan. A pan in which milk is set to allow the cream to rise; or in which it is heated or cooled as the circumstances may require, for churning or for cheese-making.

Figs. 1725, 1726 show the "Iron Clad" milk pans arranged in battery and having double bottoms in which by means of pipes a flow of hot or cold water is obtained. In Fig. 1725 the water proceeds from an elevated reservoir and is supplied to either or all of the pans by means of faucets. In Fig. 1726, *A* is the pipe from the boiler leading to pans. *B*, the hot water pipe spigot. *F* is the waste-water pipe, *G* the sour milk pipe. *H H* are thermometers for indicating temperature.

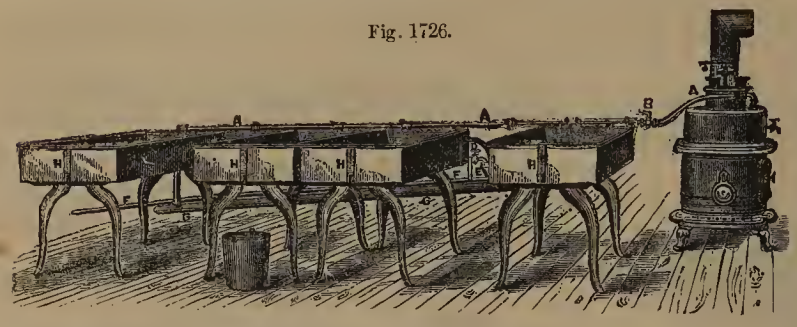
Fig. 1725.

Milk Pans with Water Flow.

Milk Scale. See Creamery Scale, Fig. 725, p. 230, *supra*.

Milk Strain'er. A funnel-shaped pan with wire gauze in the bottom to strain foreign matters

Fig. 1726.



"Iron Clad" Milk Pans with Heater.

from milk. That shown in Fig. 1727 has a pyramidal strainer which gives a much increased surface and corresponding efficiency.

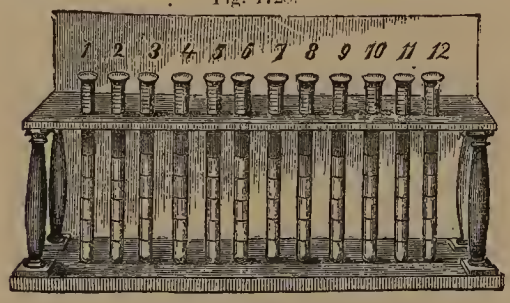
Fig. 1727.

Pyramidical Milk Strainer.

Milk Test. A *lactometer* or *lacto-densimeter*, which see. See also CREMOMETER.

Milk Test'ing Tube. A form of lactometer in which various milks or milks of different cows are placed under exactly the same conditions, in graduated tubes of the same measurements.

Fig. 1728.



Milk Testing Tube.

Mill. See under the following heads: —

Aplatisscur.
Apple grinder.
Army mill.
Aspirator.
Attrition mill.
Bean mill.
Bone mill.
Breaking down machine.
Buckwheat huller.
Cake breaker.
Cake grinder.
Cement mill.
Charcoal grinding mach
Chilian mill.
Cider mill.
Clay mill.
Clover huller.
Coffee mill.
Concasseur.
Corn cracker.
Corn mill.
Corn sheller.
Cotton-seed huller.
Cracking machine.
Crusher.
Crushing mill.
Cylinder grinding machine.
Cylinder mill.
Decorticator.
Degerminator.
Disintegrator.
Drug mill.
Eccentric mill.
Facing machine.
Farm mill.
Feed mill.
Fertilizer mill.
Flouring mill.
Fodder mill.
Furrow-dressing machine.
Grain crusher.
Grain mill.
Grain scourer.
Grain smutter.
Granulating process.
Grape mill.
Grinding machine
Grinding mill.
Grist mill.
Grits mill.
High grinding
Hominy machine.
Hominy mill.
Hone.
Huller.
Incorporating mill.
Kibbling mill.
Lime cracker.
Low milling.
Maize mill.
Malt crusher.
Middlings mill.
Millstone dresser.
Mixing machine.
Mortar mill.
Mortar mixer.
Oat mill.
Oat crusher.
Oil-cake breaker.
Oil-cake mill.
Pulverizer.
Pulverizing mill.
Rice huller.
Rock breaker.
Rock crusher.
Roller mill.
Root grinder.
Root pulper.
Salt mill.
Saltpeter and sulphur grinding mill.
Saltpeter, sulphur, and charcoal mill.
Scourer.
Sectional mill.
Semolina machine.
Smut machine.
Smut mill.
Spice mill.
Stamp mill.
Stamping mill.
Stone breaker.
Stone crusher.
Talc mill.
Vertical-stone mill.
Wheat brush.
Wheat cracker.
Wheat scourer.
Yucca grater.
Ore crusher.
Paint mill.
Paint mixer.
Pearling.
Plaster mill.
Portable mill.
Powdering machine.
Process milling.

See also: Mill feeder and tell-tale, *Teter* . . . * "*American Miller*," v. 123.
Middlings machinery.
Gent . . . . . "*Scientific American Sup.*," 2578.
New process . . . . "*Scientific American Sup.*," 397.
Oliver Evans . . . . * "*Scientific American Sup.*," 2589.
Portable, *Munson* . . * "*Scientific American*," xxxix. 70.
French . . . . . * "*Scientific American*," xli. 243.
See also MIDDLINGS; MIDDLINGS PURIFIER; CYLINDER MILL; PROCESS MILLING; HIGH MILLING, and references *passim*.

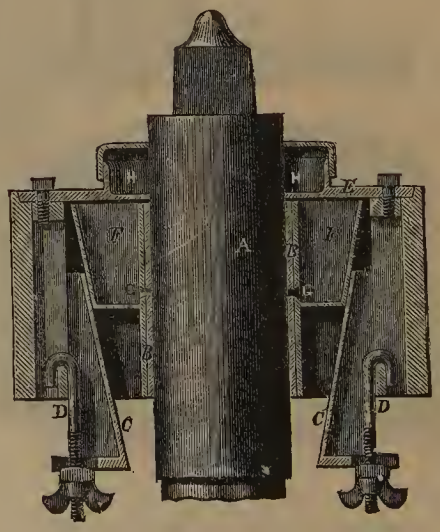
Books on mill-wrighting: —
Box. "*Practical Treatise on Mill Gearing.*" London, 1867.
Craik. "*Practical American Millwright and Miller.*" 8vo. Phila., 1870.
Dixon. "*Practical Wheelwright and Engineer's Ready Reckoner.*"
Evans. "*The Young Millwright and Miller's Guide.*"
Hughes. "*The American Miller and Millwright's Assistant.*"
Pallet. "*The Miller, Millwright, and Engineer's Guide.*"
Templeton. "*Engineers, Millwrights, and Mechanics' Pocket Companion.*"

Mill Board Cut'ter. A machine for cutting to size mill and card boards for binding, etc. They are made with pivoted, or with circular knives.

See BOARD CUTTER, Fig. 354, p 113, *supra*; MILL BOARD CUTTER, Fig. 3149, p. 1440, "*Mech. Dict.*"; CARD BOARD CUTTER, Figs. 539-541, p. 166, *supra*.

Mill Bush. The lining box in the eye of a millstone. Fig. 1729 shows the parts in the bed stone and those attached to the spindle making a

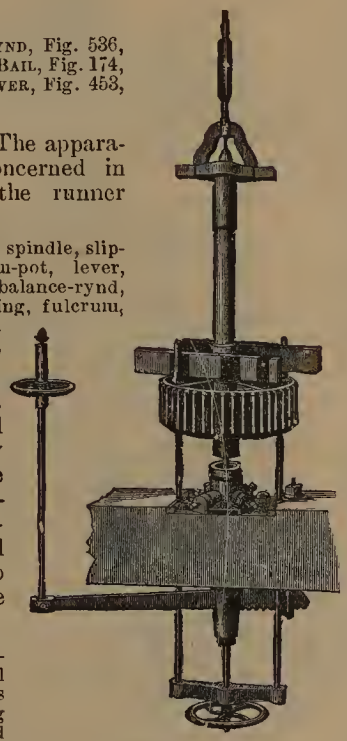
Fig. 1729.



Mill Bush.

joint, by means of the parts *B F C*, and *C D E H*, to give a snug fit, and prevent flour from working downward. The balance-rynd (not shown) is placed on the cock-eye of the spindle, and supports the runner.

Fig. 1730.



Mill Driver.

See also BALANCE RYND, Fig. 536, p. 216, "*Mech. Dict.;*" BAIL, Fig. 174, p. 66, *supra;* BUHR DRIVER, Fig. 453, p. 143, *supra.*

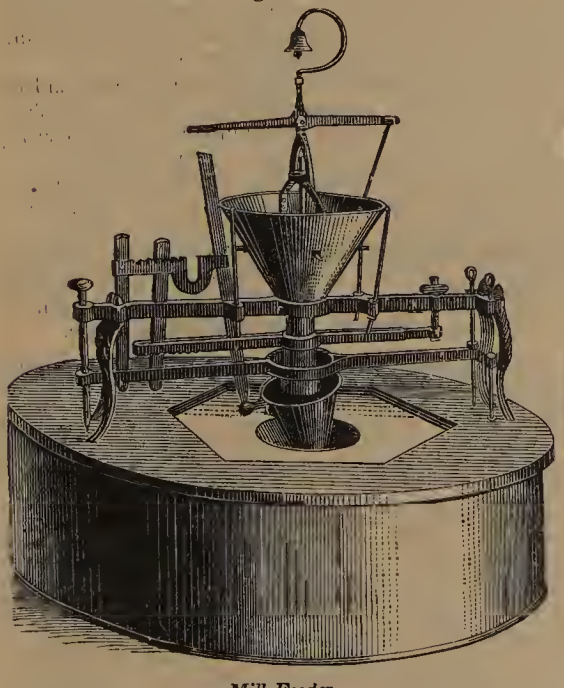
Mill Dri'ver. The apparatus immediately concerned in giving motion to the runner millstone.

The figure shows the spindle, slip-driver, set-screw, train-pot, lever, lighter screw, bail or balance-rynd, damsel, back-lash spring, fulcrum, pinion and pinion jack. See glossary, pp. 1019, 1020, "*Mech. Dict.*"

Mill Feed'er. The customary feed of a mill-stone is by a damsel on the spindle which agitates the shoe beneath the hopper and causes the grain to dribble into the eye of the runner.

Fig. 1731 shows a self-regulating silent mill feeder which also gives an alarm by the ringing of a bell when the feed runs short. The device rests by four legs upon the husk and has an arrangement of compound levers supporting the funnel which acts as a feed hopper and discharges into the lower funnel which distributes the grain around the eye of the buhr.

Fig. 1731.



Mill Feeder.

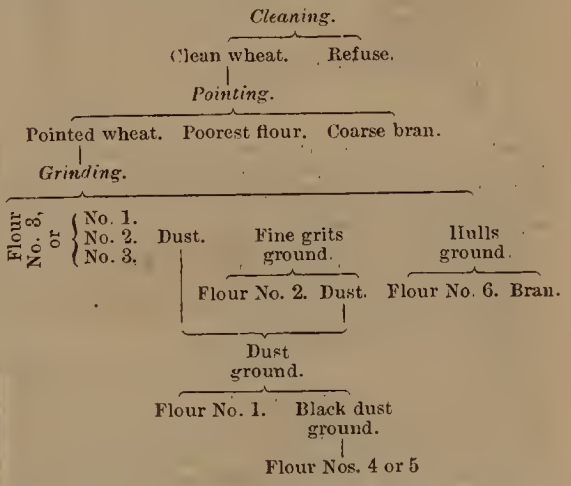
Mill File. A thin flat file used in machine shops for lathe work and draw filing.

Mil'ling. 1. (*Grain Grinding.*) In the comparison of the advantages of high and low milling respectively, it is stated by J. J. Wyngaert, editor of the German journal "*Die Mühle,*" that the Austro-Hungarian process of *high milling,* consisting of a disintegration of the tissues by successive crackings, is especially adapted to a hard and brittle wheat, such as that in the markets of Vienna and Pesth, and not to the softer varieties, more abundant in North Germany, Britain, and the United States, and which have a tougher shell and friable interior.

"The advocates of high milling rest upon the claims of the scientific solution of the problem: the reduction of the wheat-grain by a succession of alternate crackings and sortings, in which disintegration is effected by successive steps of such slight individual advance, and the graduations of the successive products are so fine that the heat produced is inconsiderable, and the ultimate product of flour free from specks and of absolute fairness is much larger than by the low-milling process. The significance of this peculiarity of the process cannot be easily over-estimated. It leaves the integrity of the cells of gluten unimpaired. They have, therefore, their natural investment of cellular tissue to protect the sensitive nitrogenous constituents of the interior from the oxygen of the air, and from the spores of microscopic vegetation always afloat in the atmosphere. Having escaped destructive crushing, they have also escaped the heat attendant upon it, and the loss of water and chemical decomposition due to it. As the chemical changes consequent upon this exposure of the gluten bring with them products of disagreeable taste and smell, the flour produced by the high milling has escaped the deterioration consequent upon the destruction of the texture of the gluten-cells."

"The physical impracticability of producing lumps from the friable interior of the soft wheat shows at a glance the inferior adaptation of this kind of wheat to the production of the numerous grades of grits which characterize the Austro-Hungarian milling. The toughness of the shell of the soft wheat makes it practicable to obtain a product in low milling in which the fine particles of bran are relatively few, and from which a flour of high order of whiteness may be obtained. The dry, brittle Hungarian wheat, subjected to the low milling process, would, by reason of the brittleness of the shell, yield a product in which the small particles of bran would be numerous, and, being of the same size, would pass through the bolt with the flour, and make it impossible to produce a flour of perfect whiteness." — *Prof. Horsford.*

By the processes of low milling, we have the following scheme of low milling treatment: —



A much more elaborate table, by Wyngaert, may be found in Prof. Horsford's "*Report on Vienna Bread,*" "*Vienna Exposition Reports,*" ii., § B, table opposite to p. 56.

The scheme of treatment of the "Fife" spring wheat of Minnesota is shown in the same report, p. 57.

In the process of high-milling, which is a step by step reduction of the grain, started with the pointed kernels, three products are obtained at each grinding:

Coarse fragments with much bran attached.

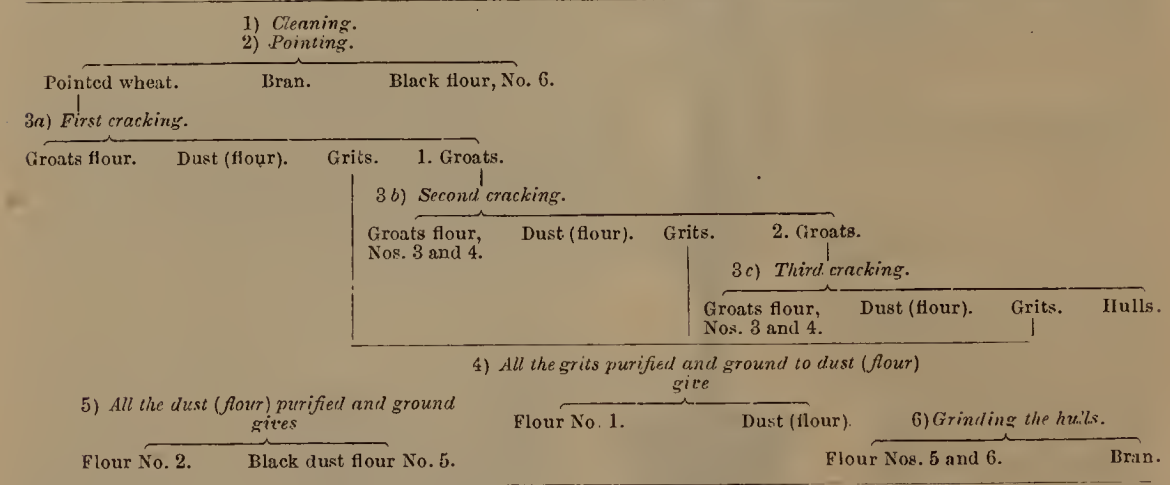
Less coarse fragments with less bran attached.

Minute fragments with little or no bran.

These are separated from each other by the sifting and purifying machine. Each of the several products is again subjected to grinding, and the product in each again sorted into grades, and so on until the last traces of the white interior of the berry have been separated from the dark hull and graded. See MIDDLINGS.

The table on the following page exhibits the products yielded in a comparatively primitive high milling establishment: —

HIGH MILLING PROCESS.



A very much more elaborate scheme may be found in Prof. Horsford's report above quoted, table opposite to p. 59.

There were produced from wheat of average weight.		83 to 84 pounds per metze.
		per cent.
A	Lady-groats	4.25
B	Table-groats, fine	
C	Table-groats, coarse	
0	Extra imperial flour	
I	Extra fine flour	5.53
II	Ordinary fine flour	5.76
III	Extra roll or semmel flour	5.51
IV	Common roll or semmel flour	6.48
V	First pollen flour	7.12
VI	Second pollen flour	13.30
VII	First dust-flour	11.85
VIII	Second dust-flour	9.95
IX	Brown pollen flour	4.36
X	Foot-flour	6.32
F	Fine bran	8.94
G	Coarse bran	6.87
H	Chicken-feed, loss, and dirt	3.76
		100.00

The terms to indicate certain results or conditions of the material in the process of grinding grain have been multiplied since the introduction of the *high-milling* process.

Prof. Horsford in his "*Report on Vienna Bread*," Washington, 1876, uses the following: —

Groats (Ger. Schrot). Broken and bruised kernels.

Middlings (Ger. Ueberschlag). Unpurified grits.

Grits (Ger. Gries). Purified groats.

Besides these are many terms known in the trade, such as *farina*, *semolina*, *cracked wheat*, etc.

Farina. A kind of grits, finely purified.

A number of terms have comparatively lately come into milling: —

Low milling is the ordinary system of mashing and repeated scraping and squeezing and a single bolting. It is attended with heating of the product, which injures the flour.

The *high milling* is a system of successive crackings with alternate removal of the finer particles and the bran as fast as produced. It is attended with but little heating of the product. There is some cracking in low milling and some mashing in high milling.

The *half-high milling*, as its name imports, partakes more of the cracking than low milling, and more of the scraping and squeezing than high milling.

The *cylinder milling* is a system of pressing and cracking, and, where the cylinders are grooved and move with unequal velocities, of tearing. Like the high milling, it produces little heat. See under each head.

Disintegration: A system in which there are neither stones nor cylinders, but in which the pulverization is effected by means of the friction of the grain upon itself, being kept in motion by beaters revolving at a high velocity in a hollow cylinder. *Carr's* process, Fig. 1665, p. 707, "*Mech. Dict.*"

See also under the following heads: —

Aspirator.
Cylinder grinding mill.
Cylinder mill.
Exhaust purifier.
Grain cleaner.
Grain dryer.
Grain separator.
Granulating process.
Grits grading machine.
Grits mill.
Grits purifier.
High milling.
Low milling.
Middlings purifier.
Mill stone.
Pointing.
Purifier.
Roller mill.
Smut machine.
Stone separator.
Unbranning machine.
Wheat cracker.
Wheat scourer.
Wheat separator.

2. (*Fine Art Metal-working.*) Giving an ornamental ridged or ribbed surface to an object by holding it against a ribbed tool which revolves in a lathe.

3. (*Metal Working.*) The cutting of metal, etc., by means of revolving cutters. See MILLING MACHINE, "*Mech. Dict.*," *et infra*.

4. (*Leather.*) Treatment in a large wooden drum or cylinder, about 8′ in diameter, and 4′ in height, water-tight, and having wooden pins projecting radially from the interior concave surface towards its horizontal shaft. The drum is revolved by a pinion, from 8 to 20 times per minute.

The mill is used for stuffing light leather, and for other purposes. After stoning, skiving, and shaving, the sides are put in the mill with some tan liquor to soften them and make them porous.

5. A mode of finishing some descriptions of goods by means of vertical fallers. See BEETLING MACHINE.

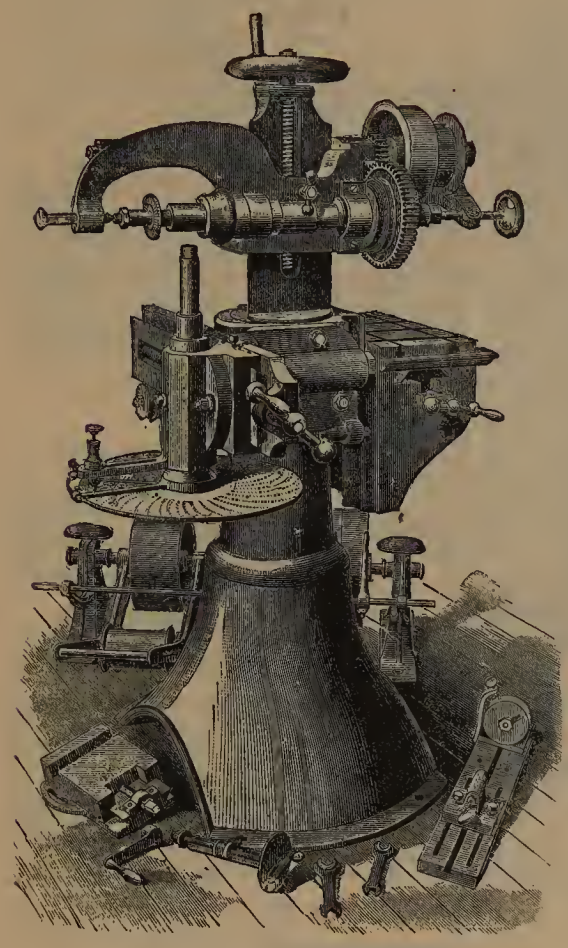
Mil'ling Ma-chine'. The subject is considered on pp. 1441, 1442, "*Mech. Dict.*," Figs. 3151, 3152. The form shown in Fig. 1732 is Lawrence's Combined Index and Plane Milling Machine.

On the circular portion of the standard is a sleeve capable of being clamped in any position, and carrying on one side the index cutting arrangement, and on the other the plane-milling table. By this arrangement of the sleeve the index can be swung round to the opposite side from the cutter, and this movement carries the milling-table under the cutter in position to be operated on, and only a moment of time is required to make the adjustment.

From the top of the sleeve, upward, the front of the standard is flat with beveled sides, and on this top part the spindle-carrier is fitted, with spindle and lateral adjustment of spindle, gears and pulley for driving the spindle, and rack-gear and handle on the back side.

The cutter-spindle carrier has a traverse of 9″, and can be operated either by a screw and hand-wheel at the top or by the lever and rack behind. On the left-hand box of the cutter-spindle is a pipe-box, bored tapering, and into which a composition-bush is fitted. Through this bush the spindle passes. On the outer end of the bush a check-nut is fitted for drawing the bush in on the taper and contracting the hole. By this method the wear of the bearing is taken up. The index is 16″ in diameter, and is drilled to cut all numbers up to 80, and all even numbers up to 150. Spur, bevel, or right or left worm-gears can be cut. It will cut gears up to 13″ diameter accurately, and by swinging the index away

Fig. 1732.



Combined Index and Plane Milling Machine.

from the cutter will cut 24″ diameter. The number of degrees in a circle are cut on the edge of the index-plate. The plane-milling table is dovetailed and gibbed into the top part of a knee-piece, which knee-piece is gibbed to one side of the sleeve, and has a traverse of 5″ on the sleeve. It is operated up or down by a hand-wheel with bevel-gears and screw. The table is 18″ × 10″, and has T-slots running both ways in the top. It has a longitudinal traverse of 18″, with a lateral adjustment of cutter-spindle across it of 5″, obtained by a screw and hand-wheel at the right hand of the cutter-spindle. It has self-adjustable, automatic feed. The extreme distance between the top of the table and the center of the cutter is 14″. The table can be set at any angle with the cutter, and, with the help of a pair of rotary centers, twist-drills or spiral-cutters can be milled. By means of the swinging sleeve true circles of greater or less diameter can be milled on the face of the work.

See also: —

Gun work, *Bement*	* "*Engineering*," xxii. 179.
	* "*Scientific American Sup.*," 675
Brainerd	* "*Scientific American Sup.*," 723.
Universal, *Britannia Co.* Br.	* "*Engineer*," xlviii. 344.
"Universal," *Brown & Sharpe*	* "*Iron Age*," xx., Oct. 11, p. 1.
Brown & Sharpe	* *Thurston's* "*Vien·a Rep.*," ii. 234.
	* "*Scientific American*," xxxv. 15.
Steam chest seats. *Campbell*	* "*Mining & Sc. Press*," xxxv. 78.
Steam chests, *Campbell*	* "*Scientific Amer.*," xxxvi. 322.
Universal, *Greenwood & Batley*, Br.	* "*Engineering*," xxvii. 375.
Greenwood & Batley, Engl.	* "*Scientific American*," xl. 383
Hand	Fig. 1306, p. 433, *supra.*
Lawrence	* "*Engineer*," xlii. 364.
For lathes, *Main*	* "*Scientific American*," xli. 38.
	* "*Scientific American*," xxxv. 271.
Newton & Co.	* "*Am. Man.*," Jan. 31, 1879, p. 16.
Pratt & Whitney	* *Thurston's* "*Vienna Rep.*," ii. 223.
Tanite	* "*Sc. American*," Oct. 31, 1874.
Universal, Br.	* "*Engineering*," xxix. 155.

Mill'-run. (*Mining.*) A test of a quantity of ore run, after reduction

Mill'stone.

A report on millstones was made by *J. M. Safford*, "*Centennial Exhibition Reports*," Group I., vol. iii., p. 176 *et seq.* See elaborate article * by Prof. Horsford in his report from the Vienna (1873), Exhibition, pp. 36-42, vol. ii.

See also: *Truax*	* "*American Miller*," iv. 21.
	* "*Scientific Amer.*," xxxiv. 198.
Bolting, *Aubin*	* "*American Miller*," iv. 120
Dress, *Jones*	* "*Scientific American Sup.*," 1824.
Snavely	* "*American Miller*," v. 53.
Walker	* "*American Miller*," iv. 29.
Theory of grooves	* "*Scientific American Sup.*," 2829.
30 illustrations	* Figs. 3156, 3157, pp. 1443, 1444, "*Mech. Dict.*"
Dresser, diamond, *Harris*	* "*American Miller*," viii. 189.
Ellis	* "*American Miller*," viii. 106.
Benton	* "*American Miller*," viii. 187.
McFeely	* "*American Miller*," viii. 408.
Dresser. *Three Rivers Man. Co.*	* "*American Miller*," iv. 70.
Harris	* "*American Miller*," iv. 71, 91; v. 39.
Griscom & Co.	* "*American Miller*," v. 121.
Exhaust, *Houland*	* "*American Miller*," iv. 95.
Exhaust and condenser *Swartwout*	* "*American Miller*," v. 63.
Glass	"*Scientific American Sup.*," 1940.
Millstone Lift	* "*American Miller*," viii. 490.
Setting, *Woodbury*	* "*American Miller*," v. 89.
Mill pick, *Lemoine*	* "*Scientific American*," xlii. 374.

Mill'stone A-larm'. A device to give notice when the supply of grain to the stone runs out or runs short.

See Fig. 3150, p. 1441, "*Mech. Dict.*" MILL FEEDER, *supra.*

Mill'stone Bush. See MILL BUSH, *supra.*

Mill'stone Crane. A device for lifting the runner off the bed-stone. See HOISTING SCREW, Fig. 1360, p. 460, *supra.*

Mill'stone Curb. The covering of the stones. A *husk* or *hurst.*

Mill'stone Dres'ser. 1. A machine for forming millstones; bringing them to shape. A species of stone-turning lathe.

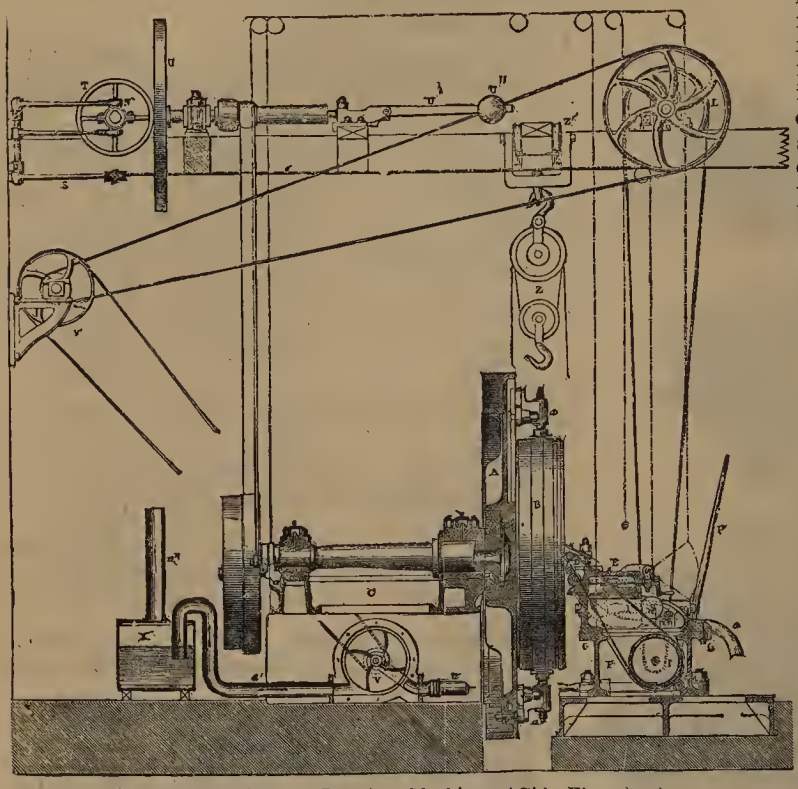
Figs. 1733-1736 show a *Rogers'* diamond tool millstone dressing machine, illustrated in the "*Bulletin de la Société d'Encouragement pour l'Industrie Nationale.*"

A is a face plate, to which the stone *B* is secured by the four clamps *a*. *C* is the bed, resting upon a masonry foundation. *D* is the rotary tool, carrying eight diamonds and revolving 3,500 turns per minute. It is mounted on a carriage, *E*, which travels across the face of the stone on slides *G*, on the support *F*. The movement of translation of the carriage is effected by the screw *H*, the rate of motion of which is proportioned to that of the stone's revolution. The diamond tool is actuated from the pulley *I* by the belt *I'*. *K* and *K'*, respectively, are fixed and loose pulleys imparting motion to the drum by means of a belt passing over the pulley *L* of the main shaft *M*. A lever, *P*, acting on pinions *P'* and *P''*, which engage in racks *Q* and *Q'*, enables the whole tool-carrying apparatus to be moved toward or from the stone, as desired. *N* is a shaft placed against a wall, which serves to set the lathe mechanism in motion, as described hereafter. On this shaft is a pulley, *T*, which transmits motion by friction to the disk *U* mounted on a shaft which is belted to the lathe arbor below. A lever, *U'*, having a counterweight, *U''*, always gives the necessary pressure to cause the contact of disk *U* and pulley *T*. This mode of transmission by friction pulley and disk imparts to the lathe arbor a variable velocity according as the tool operates upon the stone at a portion nearer to or farther from the center, so that in this way whatever part of the stone is presented to the tool, the velocity is nearly constant.

The position of the wheel *T* with relation to the disk *V* is regulated by means of the lever *S*, operated by cords *s*, which are attached to the ends of the tool carriage. A ventilator, *V*, operated by the special gearing *V'*, removes the dust produced through the tubes *v*. The air from the blower is led into a water reservoir *X*, and thence, after depositing its dust, escapes by the pipe *v''*. The traveling tackle *Z* serves to adjust the stone in the machine.

The diamond tool is separately represented in Figs. 1735 and 1736. *A* is the tool, *P* the driving pulley. Eight diamonds are mounted on the surface of the cylinder in sleeves,

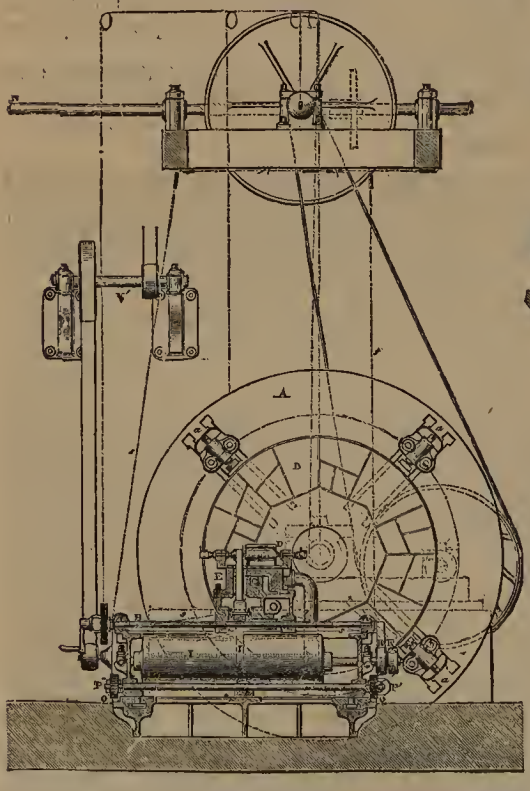
Fig. 1733.



Rogers' Millstone Dressing Machine. (*Side Elevation.*)

and in such a way that they may be caused to project more or less by means of a regulating screw. *B B'* are lubricating

Fig. 1734



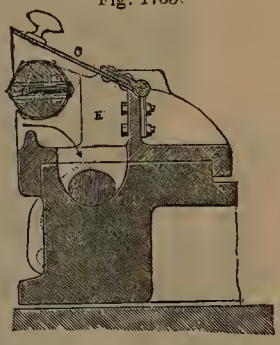
Rogers' Millstone Dressing Machine. (*Front Elevation.*)

cups, and *U* is the conduit whence dust is drawn by the ventilator from the chamber *E*, as shown by the arrows. Access is had to the tool by lifting the cover *C*.

2. A machine in which a millstone is placed while being faced. The French machine for dressing millstones by the revolving traversing diamond is shown in Fig. 1737. The cutter has a rotary motion, and also a movement of translation, on the face of the stone, parallel with the furrows; the lining being parallel on each pane.

The cutting pitch of the diamond

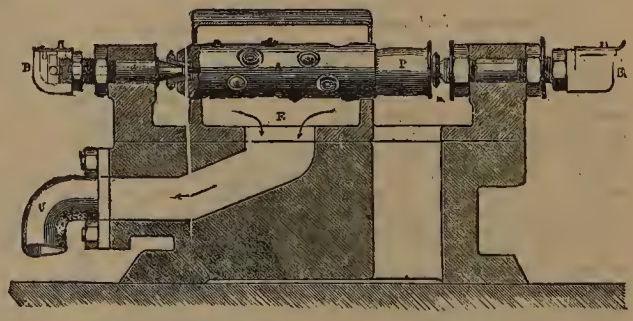
Fig. 1735.



Section of Diamond Mandrel.

is regulated by an inclined slide *H*, fixed to the cast-iron framework of the machine *I I* by the bolts *K K*. The incline of the slide is in the direction of the center of the stone, which secures uniformity in the cutting, and the inclination is regulated by means of adjustable wedges; an arrangement which secures mathematical exactness in the depth of the cut The action of the machine is similar to

Fig. 1736.



Millstone Dressing Machine. (*Enlarged View of Diamond Mandrel.*)

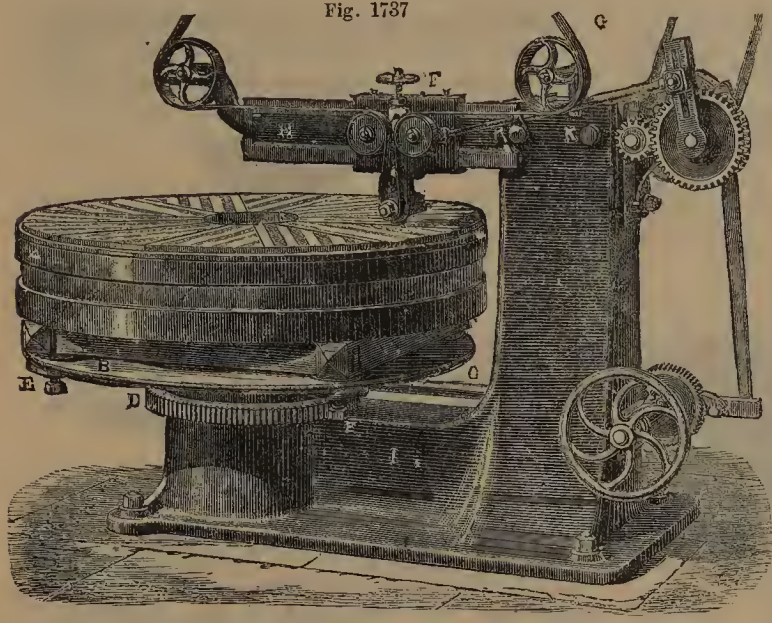
that of a milling cutter, and the course of the diamond is from the circumference to the center, and *vice versa*, the face produced on the millstone by means of the machine being partially granulated. The movement of the platform is by automatic intermittent feed connecting with pinion and master wheel *D*. *E E* are leveling screws in the plate *B*.

The *Hodgeboom* millstone dresser is shown in Fig. 1738. The post of the machine is keyed in the eye of the millstone; whereas, in the last-mentioned instance, the stone is placed on the rotatable table of the machine. The Hodgeboom machine, however, uses wheels of 8″ diam. made of corundum with a cementing material. The wheel makes 2,000 revolutions per minute. The cross head carrying the wheel runs in covered slides with steel gib and friction rollers, and so constructed as to be impervious to the dust. The idle pulleys run on hollow spindles which are self-lubricating. The standard is in the form of a tripod and easily trammed. The cross bar is fastened to the standard by means of a face plate collar, and may be raised or lowered at will. The automatic feed is a rack bar and pinion, driven by belt, and is strong, simple, and accurate.

The machine of *Hignette*, of Paris, shown at the Paris Exposition of 1878, is similarly supported on the stone, but has a rotative diamond.

Coplin's machine is on a similar principle.

Fig. 1737



Dupety's Diamond Millstone Dressing Machine.

3. A portable machine which is laid upon the stone, and the tool reciprocated thereon to dress the working face of the stone.

The *Harris* machine employs one or more revolving diamond cutters, which are run at a speed of about 3,000 revolutions per minute, making 125 cuts to the inch the entire width of furrow, leaving the natural grit of buhrs, and the furrow true and smooth. Provision is made for dressing furrows in buhrs that run either with or against the sun, and at any angle or pitch of furrow required.

The automatic feed can be set to cut any uumber of cracks to the inch, from 8 to 125.

The *Larer* dressing machine has also a diamond on a carriage moving on guides.

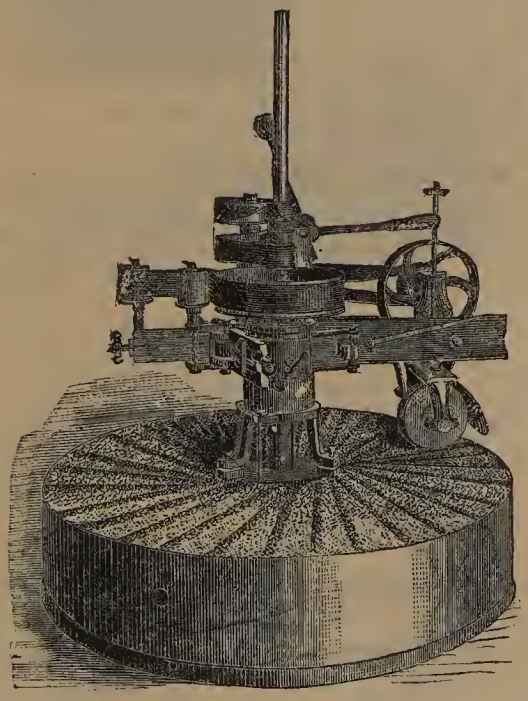
Orff's and *McFeeley's* machines for facing and furrowing use the diamond in reciprocating carriage.

The *Griscom* buhr-dresser, Fig. 1739, shows a method of operating the diamond, which is in a carriage moving on a track, which latter occupies a segment panel in a frame which lies flatly upon the face of the stone, and is fastened by a bolt passing through the eye of the stone. Any panel on the face of the stone can be reached by the adjustment of the frame on the central bolt, and the track can be brought into parallelism with the furrow by adjustment of the central end, as a tangent to a larger or a smaller circle of which the axis of the stone is the constant center.

Benton's diamond millstone dresser, Fig. 1740, is designed to furrow, face, or crack, and its carriage moves in guides on a platform which is laid upon the face of the stone.

The *Harris* dresser, shown in Fig. 1741, has a carriage carrying a mill pick. This, being hinged, will make a row of cracks as the car is pushed along, and a parallel line is made by readjusting the base-piece *A*. The fore-arm of the operator rests on the pusher, and the hand grasps the pickhandle at *K*.

Fig. 1738.



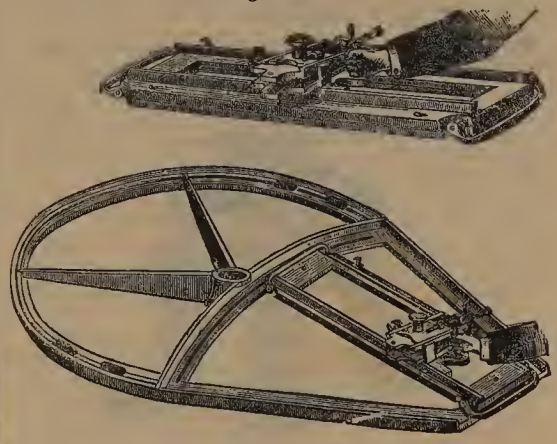
Emery-wheel Millstone Dresser.

4. A hand tool used as means of sharpening the furrows, clearing the surface of gloss or gum, restoring the cutting quality of the buhr, etc. A *facing tool.*

Frequently a block of cemented corundum. See CORUNDUM HAND-TOOL, Fig. 701, p. 224, *supra*; FURROW RUBBER, Fig. 1120, p. 363, *Ibid.*

See: *Benton*, Diamond . * "*American Miller*," viii. 358.
Coplin, emery wheel . * "*Am. Miller*," vi., May 1, 1878.
Deal, corundum block * "*American Miller*," viii. 494.

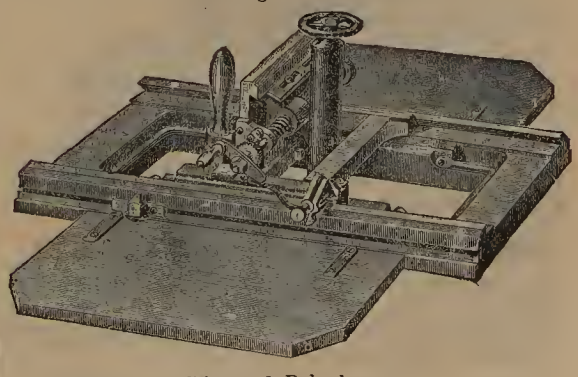
Fig. 1739.



Diamond Buhr-dresser.

Dupety, diamond . . . * "*Scientific American Sup.*," 2891.
Ellis, diamond tool . . * "*American Miller*," viii. 495.
Harris, "IXL.," Diamond tool . . . . * "*American Miller*," viii. 494.
Hodgeboom . . . . . * "*Am. Miller*," iv., May, 1876.
Hoover, diamond tool . * "*American Miller*," viii. 493.
Lehman, staff . . . . * "*American Miller*," viii. 495.
McFeely, diamond . . * "*Am. Miller*," viii., opp. p. 113.

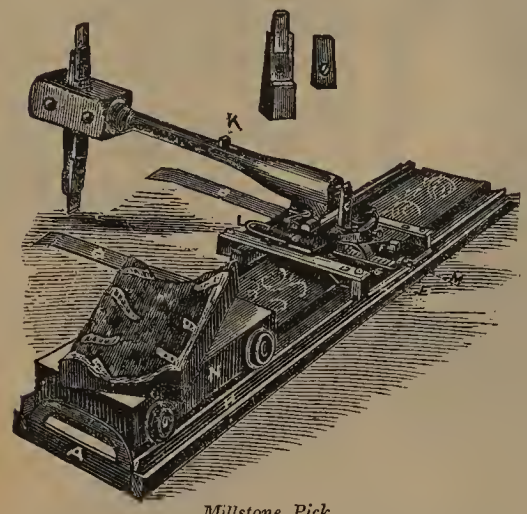
Fig. 1740.



Diamond Buhr-dresser.

Miller, rubber . . . . * *American Miller*," viii. 490.
Millot, diamond . . . * "*Scientific American*," xxxv. 383.
Roger, diamond . . . * "*Scientific Amer.*," xxxviii. 5.
Suggestions . . . . . *American Miller*," viii. 435.
Teter & Allen, corundum block . . . . . * "*American Miller*," viii. 496.

Fig. 1741.



Millstone Pick.

Mill'stone Dri'ver. That device on the millstone spindle which impinges against the bail of the runner to drive the latter.

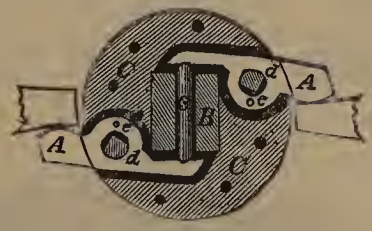
Fig. 1742 shows the *Dane* driver, which has notches to clasp the arms of the bail.

Fig. 1742.

Dane Mill-buhr Driver.

Fig. 1743 is the *Forrest* balance driver, which has lugs, *A A*, working on knife-edged pivots; these are smaller than the

Fig. 1743.



Forrest Driver.

holes which allow the lugs to move without friction against the sides of the apertures. *C* is the plate secured on spindle *B*.

See BUHR DRIVER, Fig. 453, p. 143, *supra*; BALANCE RYND, Fig. 503, p. 216, "*Mech. Dict.*"; GRINDING MILL, Plate XXII., opp. p. 1020, *Ibid.*; MILL DRIVER, *supra*.

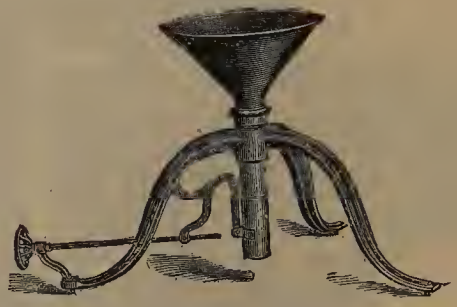
Mill'stone Ex-haust'. A means for withdrawing the air from the husk, around the periphery of the stone, in order to cool the meal, prevent choking, and expedite the work. See Figs. 3165–3167, pp. 1445, 1446, "*Mech. Dict.*"

Brubaker . . . . . * "*American Miller*," vii. 157.

Mill'stone Feed. A means of regulating the quantity of grain fed into the eye of the millstone.

The device rests by three legs upon the husk, and the con-

Fig. 1744.



Noyes' Millstone Feeder.

ductor leads downward into the eye. The gate is adjusted by a regulating screw. See MILL FEEDER, *supra*.

Mill'stone Fur'row-ing Ma-chine'. A machine for cutting the furrows in the face of a millstone. These are of peculiar shapes, and various contours. See Fig. 3156, p. 144, "*Mech. Dict.*" Some machines both cut and dress, furrow and face. See MILLSTONE DRESSER.

Mill'stone Hoist. See HOISTING SCREW, Fig. 136, p. 460, *supra*.

Mill'stone Spin'dle. See MILL DRIVER, *supra*.

Mill'stone Ven'ti-la'tor. A device for forcing a current of air in at the eye of a millstone and carrying it out at the skirt. See Figs. 3163–3167, pp. 1445, 1446, "*Mech. Dict.*"

Min'cing Knife. (*Whaling.*) For cutting the blubber into small pieces.

Domestic; disk blade . . * "*Iron Age*," xix., Feb. 22, p. 11.

Min'cing Ma-chine'. A machine with knives on a roller, used in cutting blubber small for trying.

Fig. 1745.

Mine Car.

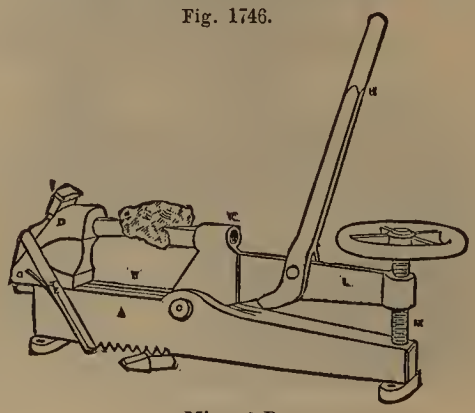
Min'cing Spade. (*Whaling.*) Used in cutting up the blubber for trying out.

Mine Car. (*Railway.*) A small four-wheeled car for carrying minerals in mines.

Mine Lo'co-mo'tive. See MINING LOCOMOTIVE.

Min'e-ral Dres'ser. A little machine consisting of a pair of chisels, one of which is adjustable and the other movable; used to split geological

Fig. 1746.



Mineral Dresser.

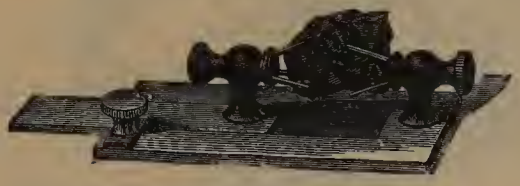
specimens with certainty, in removing superfluous portions, or exposing crystals or fossils.

The bed, *A*, has a chisel head, *B*, fastened by a link; the other chisel is on a head, *K*, moved by har *H* and lever *L*. The screw, *M*, gives a shearing action.

Canfield . * "*Engineering and Mining Journal*," xxii. 188.
* "*Iron Age*," xvii., June 8, p. 1.

Min'e-ral Hold'er. (*Microscopy.*) A means for holding a rough piece of mineral so that it can

Fig. 1747.



Mineral Holder.

be readily revolved while under examination with the microscope.

Min'e-ral Wool. (*Glass.*) Filamentous slag made by a steam blast on a falling stream of melted slag from an iron furnace.

The "hair of Pélé," the effect of the eddying gusts of wind upon the spray pellets of the masses of slag ejected from the crater of Kilauea, is a natural and constantly produced material of the same character as the artificial slag wool.

The manufactured article is used as a non-conductor, to prevent freezing of water-pipes, tanks, etc.; to prevent cooling of steam-pipes, boilers, cylinders, etc.; to prevent dampness, to keep out vermin, and to prevent the spread of fire, it being incombustible. It is formed by allowing a blast or jet of air or steam to impinge upon the surface of molten slag, which is thereby blown into filaments, producing a light material having a glassy fiber.

Player's U. S. Patent, May 31, 1870. Re-issued February 1, 1876.

The method of manufacture at the Krupp Works, Essen, Prussia, is as follows: The pig-iron furnace is provided with a tap an inch in diameter, out of which a continual stream of slag is allowed to flow, and to fall a distance of 2′ 6″, at which point the falling stream of slag is met by a strong blast of cold air, the effect of which is to separate the slag into myriads of hair-like threads, as white as snow, resembling the finest wool.

Fig 1748 shows the method adopted at the Clove Furnace, Orange Co., N. Y. The wool-house is 100′ from the furnace.

Fig 1748.

Mineral Wool Apparatus.

The slag is run into box cars, rolled to the wool-house, and there tapped. A small stream issues on to the runner, falls 3½″, and is then encountered by a jet of steam which scatters it in threads into the house, which is 30′ × 40′, and 21′ to the comb. A sheet-iron extension 10′ long reaches to the slag car. The size of the nozzle has an important bearing upon the formation of *shot*, as the pellets of slag are termed.

See: . . . . . "*Man. & Builder*," ix. 42; * x. 5.
Roof lining . . . . . "*Iron Age*," xxi., May 16, p. 18.
* "*Scientific Amer.*," xxxviii. 278.
Uses of . . . . . "*Am. Man.*," March 19, 1880, p. 7; April 2, 1880, p. 12.

Mi'ner's Bar. A crow-bar with narrow and relatively wide chisel ends at the respective extremities.

Mi'ner's Forge. A portable forge for use in a mine, to dress picks, etc. See PORTABLE FORGE, and refcrences *passim*.

Mi'ner's Inch. The term is somewhat arbitrary, the value varying in different localities.

Customary: The amount of water flowing in one second through an orifice an inch square, under a head of 6″, measuring from the upper line of the orifice. Approximately, 9 to 10 ounces by weight per second.

"In round numbers, the miner's inch is equivalent to a discharge of 95 cubic feet per hour; one cubic foot is 7½ gallons. A miner's inch would equal a discharge of 712.5 gallons per hour."—"*Mining and Scientific Press*," xxxvii. 152.

See also *Ibid.*, xxxv. 297.

Mi'ning. See:—

Cages, wire-rope connections for, *Baumann*, Ger. . * "*Engineering*," xxx. 118.
Comstock Code . . . * "*Scientific American Sup.*," 1158.
Miner's inch . . . . "*Min. & Sc. Press*," xxxvii. 152.
Deep . . . . . "*Scientific American Sup.*," 2681.
Dial, *Davis & Cochrane* * "*Engineering*," xxii. 111.
Engine, Portable, *Garrett*, Br. . . . . * "*Engineering*," xxvii. 573.
Tuxford, Br. . . . * "*Sc. American*," xxxvii. 134.
Dump, *Lee Bros.* . . . * "*Iron Age*," xxiii., May 1, p. 11.
Locomotive, narrow gage.
Lewin, Br. . . . . * "*Engineering*," xxv. 45.
Locomotives, Austria . * "*Engineering*," xxv. 507.
Mach., *Dubois & François* * "*Iron Age*," xxii., Sept. 26, p. 1.
"*Scientific American Sup.*," 980.
Machinery, heavy . . "*Scientific American Sup.*," 1859.
Machine, *Lechner* . . * "*Scientific Amer.*," xxxix. 102.
Pump, *Blake* . . . . * "*Manufacturer & Builder*," x. 193.
* "*Scientific American Sup.*," 994.
Cope & Maxwell . . * "*Mining & Sc. Press*," xxxvi. 17.
Gould & Curry mine "*Min. & Sc. Press*," xxxiv. 266.
Knowles . . . . . * "*Scientific American*," xxxiv. 51.
Pumps, mode of operating, *Moore & Dickey* . * "*Scientific American*," xlii. 338.
Pump, *Silver* . . . . * "*Scientific American Sup.*," 353.
Shafts, sinking.
Kind-Chaudron . . "*Scientific American Sup.*," 1041.
Depth of European . "*Iron Age*," xix., June 14, p. 1.
Ventil. (Cleveland, Eng.) "*Scientific American Sup.*," 107.
"*Scientific American Sup.*," 346.
* "*Scientific American Sup.*," 1112.
Root . . . . . * "*Scientific American Sup.*," 1315.
Wedge . . . . . * "*Scientific American Sup.*," 1907.

Treatise on the applications of electricity to the firing of charges, mines, torpedoes, etc. *Comte du Moncel's* "*Exposé des Application de l'Électricite*," v. 582-638. Paris, 1878.

Mi'ning En'gine. 1. A hauling engine for subterranean work in drifts and adits.
2. A hoisting engine in shafts.
3. A pumping engine to clear mines of water.
4. A mining locomotive.
Many instances are given under special names.

Mi'ning Lo'co-mo'tive. A narrow-gage locomotive built compactly, and of moderate height, to traverse the drifts of mines.

While there is much variation as to gage, number of dri-

Fig. 1749.

Mining Locomotive.

vers, weight, power, etc., the size of that shown in Fig. 1749 is within the ranges

Cylinders, diameter . . . . . 5″ to 9″.
Stroke . . . . . 10″ to 14″.

Diameter of drivers	22″ to 28″.
Wheel base	4′ to 5.25′.
Length over all	10′ to 15.1′.
Height	5′ to 0.5′.
Weight (running)	7,000 to 20,000 lbs.
Hauling capacity on level	175 to 500 tons.

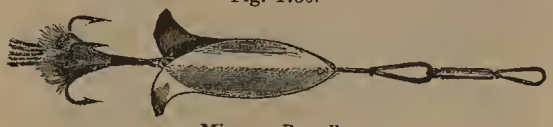
See list under LOCOMOTIVE; NARROW-GAGE LOCOMOTIVE.

Mi'ning Wedge. A gad for driving into a natural seam, or a channel cut or bored, to split off a mass of coal, or what not.

A wedge for bringing down coal, on the principle of the plug-and-feather, is shown in * "*Scientific American Supplement*," 1907.

Min'now Pro-pel'ler. A bait for trolling, having a bright *spoon* which rotates by contact with

Fig. 1750.



Minnow Propeller.

the water. Behind the propeller is a feather bait with hooks. Fig. 1750 shows Chapman's minnow propeller.

Min'ute Clock. A stop clock used in making tests of gas.

Goodwin's "*Amer. Gas-light Journal*," * July 3, 1876, p. 7.
Minute clock, comb. with meter and gas index, *Ibid.*, p. 7.

Mir'ror. See pp. 1452, 1453, "*Mech. Dict.*"
(*Surgical.*) To reflect light into a cavity, as the larynx, the meatus auditorius, the eye, the rectum. The laryngoscope, endoscope, ophthalmoscope, etc., use mirrors.

See also:—

Mirror barometer	* "*Scientific American Sup.*," 2847.
Folding, *McEvoy*	* "*Scientific American*," xlii. 354.
Holder, *Webb & Myrick*	* "*Scientific American*," xliii. 403.
Japanese magic, *Mallet*	* "*Engineer*," xlvii. 307.
Japanese	* "*Scientific American*," xl. 280.
Japanese magic	"*Sc. Am. Sup.*," 1326, 2654, * 2847.
Manufacture, silver	"*Scientific American*," xxxv. 35.
Mercury	* "*Scientific American Sup.*," 574.
Mirror telegraph	"*Scientific Amer.*," xxxix. 310.

See also POLEMOSCOPE.

Mir'ror Gal'va-nom'e-ter. An instrument for measuring the deflection of the astatic needle under conditions of electric excitement. A mirror is attached to the needle, and the reflected pencil of light becomes as it were a pointer traversing a scale.

The first use of a mirror attached to a moving body to indicate angular displacements was by Galileo in a pulsometer, the small mirror being laid on the pulse, the beam of reflected light was received on a wall or screen. See *Sphygmograph*.

"*Engineering*," vol. xxiv., p. 346, refers to the application of the idea by Gauss, in a telescope or eye-piece, and by Tyndall in his lectures, in throwing upon a screen the image of a dial and needle of an ordinary astatic galvanometer. See also "*Engineering*," xxii. 115.

Mr. Charles Brook used the mirror in his photographic self-recording galvanometers, in 1851, to reflect a spot of light upon a moving strip of sensitized paper.

Sir William Thomson used the spot of light, thus reflected, on an index traversing a scale, in his sub-oceanic telegraph instruments, *b*, Fig. 2150, p. 939. "*Mech. Dict.*"

See also instruments by W. J. Wilson and Prof. Silvanus P. Thomson, described in "*Engineering*" above cited. Also paper by Judd, "*Journal Society Telegraphic Engineers*," v. 248.

Mi'ter. A scribe or guide for an oblique cut. The term *miter* may be held to include only the angle of 45°, the half of the rectangle, and the *bevel* to refer to chamfers or oblique angles generally. The custom, however, is not absolute.

Fig. 1751 is a combination instrument consisting of a rule, square and miter, capable of many uses.

Fig. 1751.

Iron Frame Miter and Square.

Mi'ter Board. A miter box in which a piece is laid while the saw reciprocates between guides which cause it to make the kerf at the prescribed angle.

In Stevens's miter-board, Fig. 1752, one of the guides is adjustable on a graduated quadrant so as to set the guide to saw at any required angle with the base.

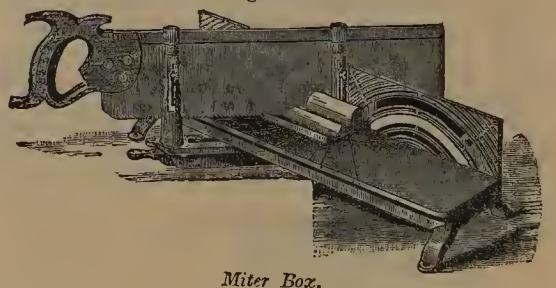
Fig. 1752.

Miter Board.

Mi'ter Box. A tool with a bed and a fence, against which, as a base, an object is held, while a saw working in guides makes a kerf at any determined angle.

In the Langdon miter box, Fig. 1753, this angle is adjustable, one of the guides being set in accordance with the scribe lines on the bed.

Fig. 1753.

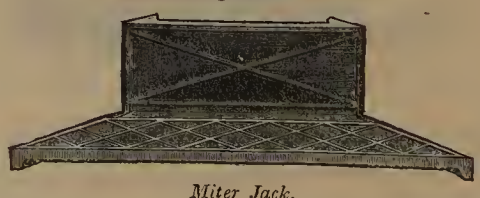


Miter Box.

Mi'ter-box Saw. A wide-bladed tenon saw for cutting miters. See Fig. 1753.

Mi'ter Jack. A templet used in making and fitting all kinds of small miters on moldings. Fig. 1754.

Fig. 1754.



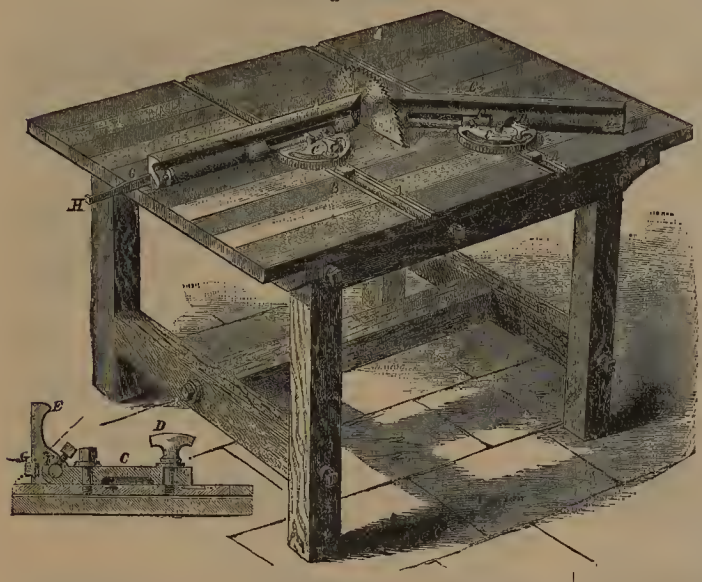
Miter Jack.

Mi'ter-ing Ma-chine'. A machine on which stuff is sawed to a determined angle. Its most frequent use is to saw off the ends of pieces obliquely in order that they may be united to form a frame. The uses are very various. See p. 1453, "*Mech. Dict.*"

The mitering machine, Fig. 1755, has a table, a circular saw, and two fences adjustable to any angle, and capable of a movement of translation across the table, in order to saw off the end of a piece of stuff held against the fence and moved toward the saw.

Miter cutter, *Fox*	* "*Scientific American*," xli. 134.
Miter jack	* "*Manuf. & Builder*," x. 88.
Miter machine, *Tiernay*	* "*Scientific Amer*," xxxvii 214.

Fig. 1755.



Mitering Machine.

Mi-trail-leuse'. The subject has been considered on pp. 1454–1456, * "*Mech. Dict.*," where the French army, the Abbertini, and the Taylor systems are shown. See also MACHINE GUN, pp. 569, 570, *supra*.

Mixed Clay Ware. (*Ceramics.*) Ware made of portions of clay of different colors, to give various marbled or mottled effects; or to give the parts of a vase or other object different colors.

See of the former order, SCRODDLED WARE and TORTOISE-SHELL WARE.

Pâte changeant is a porcelain which has a peculiar changeable color as viewed by solar or gas-light, or at different angles.

Mix'ing Ma-chine'. 1. A machine for compounding. See list under MILL, *supra*. Also DOUGH MIXER, *Ibid.*

2. (*Gunpowder.*) A revolving hollow copper drum with interior spokes to mix a batch of the dry materials; say 50 lbs. in all, at one operation.

See "*Ordnance Report*," 1879, Appendix I., Plate II., Fig. 4; and description on p. 99.

Gunpowder, Fr. . . . . * "*Engineering*," xxxv. 37.
And grinding pan, *Mather*, Br. * "*Engineering*," xxix. 205.
And kuead., *Pfleiderer*, Br. * "*Engineering*," xxviii. 483.
Pottery clay . . . . . * *Laboulaye's* "*Dict.*," iii., "*Poterie*," Figs. 2163–2166.

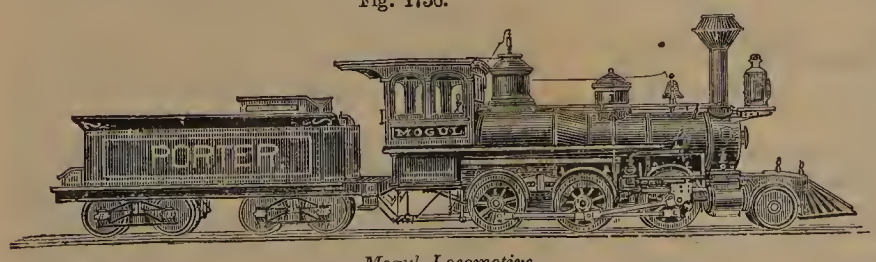
Mod'el-ing Clay. Dry clay kneaded with glycerine.

Plastilina: Clay, 3; sulphur, 6; oxide of zinc, 1; fatty acids, 2; fats, 10. First saponify the zinc white with oleic acid, which then mix with the other fatty acids, add sulphur in flowers, and the clay in a dry powder.

Or: Glue, 8, with zinc oxide, 1; add oleic oil, 4; wax, 2; sulphur, 6; clay, 3.

Mo-gul'. The name of a class of locomotives adapted for heavy freight traffic. It originated in the Baldwin Locomotive Works with the "E. A. Douglas," built in 1867. It is made in several sizes, but with the typical three pairs of connected drivers and a swinging pony truck in front.

Fig. 1756.



Mogul Locomotive.

Utilizing, as it does, nearly the entire weight of the engine for adhesion, the main and back pairs of driving wheels being equalized together, as also the front driving wheels and the pony wheels, and the construction of the engine, with swing truck and one pair of driving wheels without flanges, allowing it to pass short curves without difficulty, the *Mogul* is generally accepted as a type of engine especially adapted to the economical working of heavy-freight traffic.

Mo'hair.

"Mohair, the fleece of the Angora [Asia Minor] goat, is not a mere substitute for wool, but occupies its own place in the textile fabrics. It has the aspect, feel, and luster of silk, without its suppleness. It differs materially from wool in the want of the felting quality; so that the stuffs made of it have the fibers distinctly separated, and are always brilliant. On account of the stiffness of the fiber, it is rarely woven alone; that is, when it is used for the filling, the warp is usually of cotton, silk, or wool, or the reverse. The distinguishing qualities of the fiber are luster, elasticity, and durability. These qualities fit the material for its chief use, — the manufacture of *Utrecht velvets*, commonly called *furniture plush*, the finest qualities of which are composed principally of mohair, the pile being formed of mohair warps, which are cut in the same manner as silk warps in velvet." — *Hayes'* "*Centennial Reports*," v. 78.

See also *Hayes'* "*The Angora Goat: its Origin, Culture, and Products*," published in vol. xi. of the "*Proceedings of the Boston Natural History Society.*"

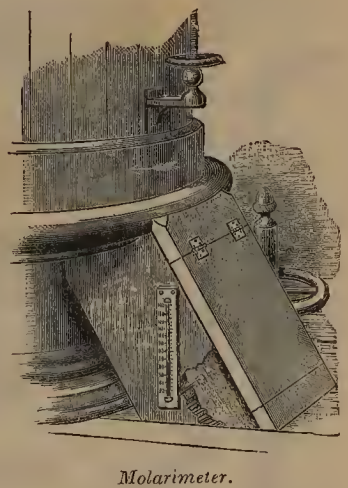
Mo'hair Gla-cé'. (*Fabric.*) A goat's-hair and cotton French dress goods.

Mo'hair Lus'ter. A black dress goods, resembling alpaca, consisting of mohair woven with cotton warp. Also called *brilliantine*.

Moist Bat'te-ry. (*Electricity.*) A battery invented by M. Trouvé, consisting of a pile of zinc and copper plates separated by paper disks; the paper in contact with the copper being saturated with a solution of sulphate of copper, and that in contact with the zinc serving to hold the zinc sulphate produced during the action of the battery.

"*Scientific American*," * xxxvii. 323.
"*Telegraphic Journal*," * v. 78.
Niaudet, Am. transl., * 112.

Fig. 1757.



Molarimeter.

Mo'lar For'-ceps. (*Dentistry.*) Heavy forceps for extracting the molars; or cow-horn forceps for eradicating roots when the crowns have decayed below the alveolar process.

Mo-la-rim'e-ter. (*Milling.*) An instrument invented by E. Campbell, for ascertaining the temperature of the meal as it flows from the mill spout. Fig. 1757.

It is a thermometer with a bent leg; the bulb exposed

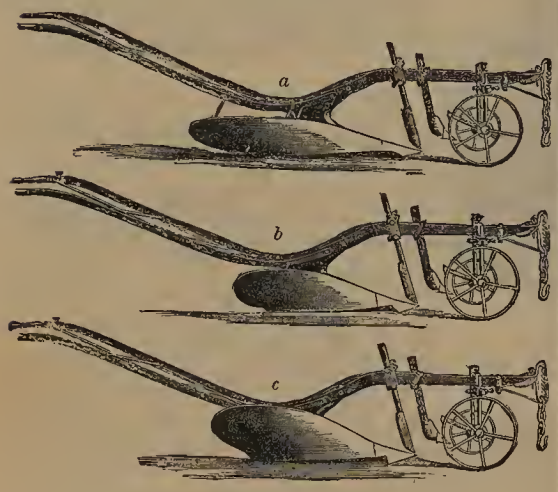
to the flow of meal in the spout, and the graduated limb exposed to observation on the outside of the spout.

"*Leffels' Milling and Mech. News*" . . . . * viii. 85.

Mold'-board. The spiral wing on the side of a plow body, to raise, curve, and press over the furrow slice cut by the share and colter.

The following are recognized in Britain and France: —

Fig. 1758.

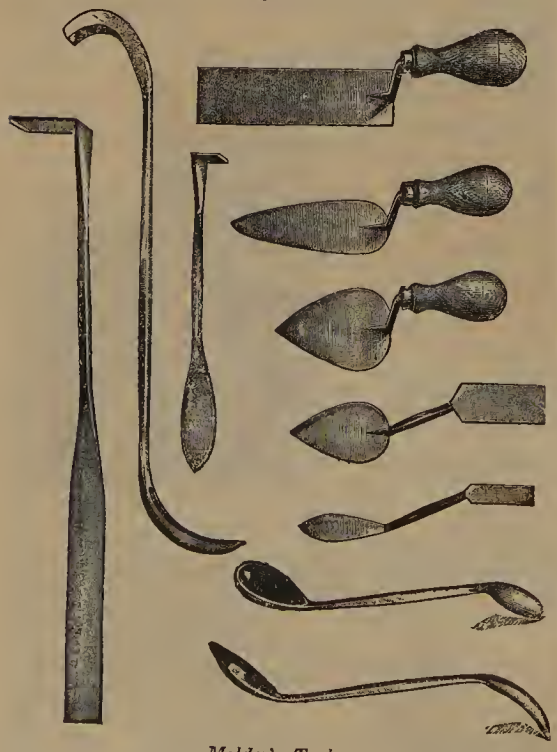


Mold-boards.

a. Long breast: *versoir allonge.*
b. Short breast: *versoir court.*
c Deep breast: *versoir profond.*
Medium breast: *versoir mixte.*
The latter is not shown in the illustration.

Mold'er's Tools. Various sizes and shapes of

Fig. 1759.

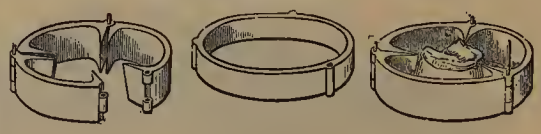


Molder's Tools.

trowels, cleaners, feeding rod, ladle, loosening bar picker, piercer, rammer, slicker, strickle, vent wire, etc.

Mold'ing Flask. (*Dentistry.*) A jointed receptacle in three parts, secured by steady pins, in

Fig. 1760.



Molding Flask.

which the vulcanite model and plaster mold are secured in making dentures ready for the muffle.

Mold'ing Ma-chine'. 1. (*Wood Working.*) A planing machine for sticking moldings on boards. See examples, pp. 1467, 1468, "*Mech. Dict.*"

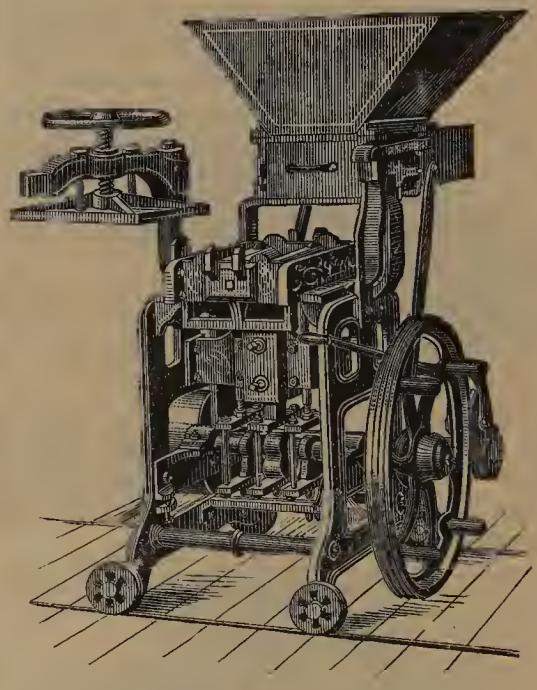
Bentel, Margedant & Co.	* "*Manufact. & Builder*," viii. 151.
Houston, Smith & Co.	* "*Manufact. & Builder*," viii. 177.
Upright, *Blaisdell*	* "*Scientific American*," xxxvi. 86.
Paneling, *Boult*	* "*Scientific American*," xl. 323.
Coleman & Morton, Br.	"*Iron Age*," xxiv., July 3, p. 13.
Gear wheels	* "*Iron Age*," xxiv., Oct. 9, p. 9.
Polisher, *Dayton*	* "*Scientific Amer.*," xxxiv. 175.
Goodell & Waters	* "*Manufact. & Builder*," xi. 52.
Richards	* "*Engineering*," xxv. 261.
Richards & Atkinson, Br.	* "*Engineering*," xxviii. 224.

See also Reversing Machine, *infra.*

2. (*Foundry.*) A machine for making loam molds from patterns. See Figs. 3195, 3196, 3202, pp. 1466–1468, "*Mech. Dict.*"

Aiken & Drummond's machine is shown in Fig. 1761. The ordinary snap or iron flask is used. The pattern is forced

Fig. 1761.



Foundry Molding-machine.

down into the sand, making a compact face, and a soft back for the escape of the gases. The flask being put in place, the sand is dropped into it from the hopper, the pattern adjusted, platen brought over, pressure applied, relieved, the pattern withdrawn, flask closed and removed.

The match machine, for foundry use, is made with a plunger and follower, the patterns being attached to an independent head, which is fitted to rest on the plunger head. Metal plates are fitted to surround the patterns, and are attached to the follower-head. The follower and pattern-heads work independent of each other in a box, which serves as a guide and gage for the proper amount of sand to supply the reduction in compression. On this box adjustable pins and sockets are placed to hold flasks. The sand hopper is furnished with a drawer having an independent bottom. When the drawer is pulled out, it leaves the bottom at the edge of the flask, where it passes over and deposits the sand. It is then retracted, striking off the surplus sand, and ca-

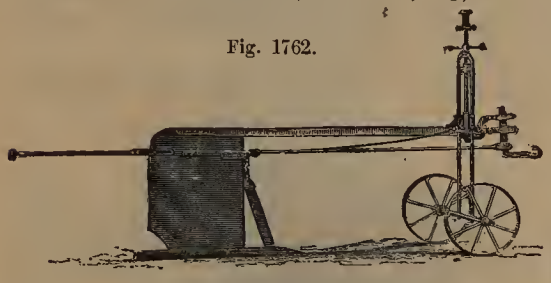
gaging the bottom at the proper place, carries all back into the hopper. A swinging binder-plate is then brought over, and holds the flask in place to resist the pressure, while the revolving of the shaft, on which is a series of cams, raises the pattern-head and follower simultaneously, forcing the patterns and sand into the flask, and as the shaft continues its revolution the patterns are withdrawn from the mold, while the molded sand is protected by the follower plate, which is afterward withdrawn, leaving the mold complete and ready to be carried away. The match molders are intended to mold for such castings as gas, steam, and water-pipe, fittings, cocks, valves, and other plumbers' goods, household and carriage hardware, etc.

Molding mach., founder's
Aiken & Drummond . * "*Iron Age*," xxi., April 4, p. 1.
Pipe, *McNeal & Archer* . * "*Iron Age*," xxi., May 2, p. 6.
Gelatine for plaster . . "*Scientific American Sup.*," 2030.
Foundry, *Sebold & Neff* * "*Scientific American Sup.*," 3913.
Woolnough & Dehue * "*Engineering*," xxix. 355.

Mole Plow. (*Agriculture.*) An implement which makes an underground channel for water to follow and relieve the soil.

Instances are shown on p. 1469, "*Mech. Dict.*" The French mole plow, shown in Fig. 1762, has a wide, deep, and thin

Fig. 1762.



French Mole Plow.

plate which connects the mole with the beam and makes but a narrow incision in the soil.

Mon'o-gram Ma-chine'. A foot press for stamping monograms, initials, sizes, etc., on paper or manufactured articles.

Mon'i-tor Car. (*Railway.*) One with a clear-story or central elevation above the surrounding portions of the roof.

Monk'ey Wheel. A simple tackle-block over which a hoisting rope runs. A *whip-gin*, *gin-block*, or *rubbish pulley*.

Mon'ni-er Pro'cess. (*Metallurgy.*) A process of reduction of auriferous copper ores.

It consists, substantially, as follows: 1. Calcination of the metallic sulphides with a portion of sulphate of soda, or other similar salt. 2. Lixiviation of the calcined ore. 3. Evaporation and crystallization of the sulphates. 4. Reduction of the sulphate of copper. 5 Smelting into ingot copper. 6. Amalgamation of any gold residuum. The working details are explained at length in "*Mining & Sc. Press.*"

Mon'o-lith. See statement and instances, "*Mech. Dict.*," p. 1473.

A block of sandstone at the Dark Hollow Stone Quarry, near Bedford, Ohio, was lifted April, 1880. It was 40′ by 50′ square, 30′ deep. Estimated weight, 6,000,000 pounds. 185 slip wedges were used in detaching it. It was cut up into building stones, loading nearly 300 cars.

A block of granite, 59′ long by 5½′ square at the base and 3½′ at the top, has been taken from the quarry of Vinalhaven. It is for the shaft of the General Wool Monument, at Troy, N. Y.

Mon'o-phote Reg'u-la'tor. (*Electricity.*) A voltaic-arc regulator adapted to but a single light on a circuit: as distinguished from *polyphote* regulator.

The current is regulated by its intensity. Traversing an electro-magnet and a voltaic arc, should it grow weak the electro-magnet weakens also, and allows the carbons to approach each other.

Foucault's and *Duboscq's* apparatus have springs to maintain the normal distance between the carbons. In *Siemens'*, *Maxim's*, *Jasper's*, *Crompton's*, *Carré's*, and others, the positive carbon holder acts by its own weight to preserve the normal distance. The regulating is done by electro-magnet or by solenoid; currents continuous or alternating, in different systems.

Mon-tag'nac Coat'ing. A fabric named from its inventor, M. Montagnac, of Sedan; also known as *cloth velvet*.

The pile of the surface is usually furnished by fibers of cashmere wool, incorporated in the yarns of the fabric, and they are straight and perpendicular to the surface, the cloth having the aspect of a silk-velvet, but with a softness peculiar to the cashmere fiber. The pile is developed on the surface by *battage*, or beating the moistened cloth with elastic rods.

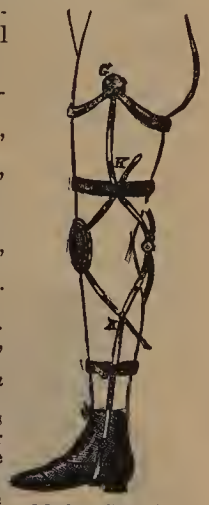
Moon Knife. (*Leather.*) A circular knife, 10″ or 12″ in diameter, having a round 4″ or 5″ hole in the center to introduce the hands in working it. It is concave, presenting the form of a conical zone. The concave part is applied to the skin. The edge is turned over a little to prevent it from entering too far into the leather. It is used for shaving off the coarser, fleshy parts of the skin.

Moor'ing Swiv'el. (*Nautical.*) A link of iron in a mooring chain to allow turning without kinking. See SWIVEL, Fig. 6137, "*Mech. Dict.*"

Mooring anchor, *Protheroe*, Br. . . "*Engineer*," xliii. 392.

Mor'bus Cox-a'ri-us Splint. (*Surgical.*) One for diseases of the hip joint. It requires an extension apparatus, and in some approved forms consists also of a pelvic band, perineal strap, knee cap, and foot-piece.

Fig. 1763.



Morbus Coxarius Splint.

Sayres' long splint, for hip-joint disease, Fig. 175, p. 111.
Andrews' morbus coxarius splint, Fig. 191, p. 126.
Holthouse's spiral spring extender, Fig. 145, p. 89.
Hutchison's hip-joint apparatus, Fig 89, p. 47.
Bauer's hip-joint apparatus, Fig. 85, p. 48.
Hamilton's wire-gauze splint, Fig. 84 *a*, *b*, p. 43.
Davis' hip-joint splint, Fig. 81, p. 41.
Sayers' short hip-joint apparatus, Fig. 82, p. 42.
All in *Tiemann's* "*Armamentarium Chirurgicum*."
Dr. *Stephen Smith's* morbus coxarius apparatus throws the extension or weight upon the gluteal muscles. See also LEG SUPPORT, etc.

Mor'tar. 1. A cement. See p. 1477, "*Mech. Dict.*"

Black brick and Black mortar. — Brick becomes black through the process of baking when the brick clay has been mixed with either the protoxide of iron, the oxide of cobalt, or the peroxide of manganese; 1 part of the iron or manganese to 10 of clay is sufficient. Sometimes two or three of these ingredients are used together. To make black mortar, mix the lime with fine anthracite coal-dust instead of sand.

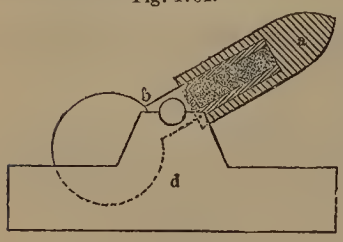
Sawdust instead of hair used as a bond in French mortar: cement, 1, lime, 2; sawdust, 2; sharp sand, 5.

Selenitic Mortar: Sulphate of lime or sulphuric acid is mixed with the water, and ground to (for 4 minutes) a thin paste; add sand or burned clay, and continue the grinding for 10 minutes. The mortar sets quickly; is very tenacious: resists great pressure. — *Col. Scott.* London "*Mech. Magazine*."

See: Mortar? What is . "*Building News*"; "*Van Nostrand's Mag.*," xxiii. 413.
"*Mortier*" . . . . . *Laboulaye's* "*Dict.*," iv, ed. 1877.
Mixer, steam, *Barrows & Stewart*, Engl. . . . "*Scientific American Sup.*," 839.
Poole & Hunt . . . * "*Manuf. and Builder*," x. 31.
* "*Min. and Sc. Press*," xxxvi. 369.
Mill and engine, portable, *Barrows & Stewart*, Br. . . . . * "*Engineer*," xlii. 272.
Mill, *Ward*, Br. . . . * "*Engineering*," xxi. 77.
Portable, *Llewellyn & Cubitt*, Br. . . . * "*Engineering*," xxiii. 428.

2. A form of ordnance, p. 1488, *"Mech. Dict."*

Fig. 1764.



Mortar.

a. Projectile in section.
b. Mortar.
c. Powder chamber.
d. Bed.

Fig. 1764 is a section of a small Austrian rifle mortar in which the projectile covers the outer part of the mortar. The embraced portion is a hexagonal spiral, like a Whitworth bolt, and the projectile is of corresponding shape, and fits it like a cap, and slips off when fired. The counterbalance, *b*, is to give preponderance to the rear of the trunnions.

Prussian rifled mortar of 21 cm. "*Ordnance Report*," 1878, Appendix L., p. 93, and Plate VII. *a*, Fig. 8.

Mor'tar Car'riage. (*Military.*) The distinction between cannon and mortar carriages has been less marked since the mortar has been lengthened, rifled, and used for direct and curved fire, with solid and hollow shot, as well as shell.

Mortar carriages of modern form, Austrian, German, Krupp's, and Russian, are to be found in Plates XLI.–XLV., "*Ordnance Report*," 1877.

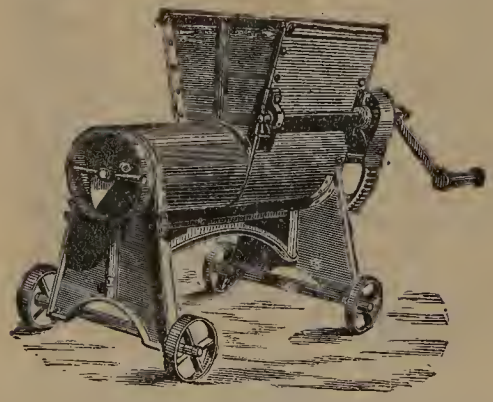
Russian rifled mortar and carriage, *Ibid.*, p. 521, and Fig. 12.

See also: "*Scientific American Supplement*" . . 514

Mor'tar Mix'ing Mill. A mill for intimately mixing the ingredients of mortar. Figs. 3230, 3231, p. 1480, *"Mech. Dict."*

Reynolds, London, portable mortar mill is shown in Fig. 1765. It is hand-worked, and is moved to the building spot.

Fig. 1765.



Mortar Mixing Mill (*English*).

The hopper being filled with the materials, the spindle in the center of the cylinder, having 14 wrought blades, is set in motion by the handle, and the mortar is ready for use when discharged from the outlet.

Mortar machine at Dunkerque and Gravelines. "*Vienna Exposition Report*," chap. viii., Plate XVII., vol. iii., § C., p. 59.

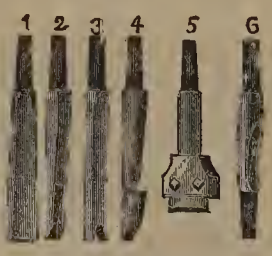
See also BÉTON, CEMENT, CONCRETE, MORTAR, etc., "*Mech. Dict.*," *et supra.*

Mor'tis-ing Chis'el. The chisels used in mortising machines are known as follows: —

1. Core punch.
2. Ordinary chisel.
3. Sash chisel.
4. Lip chisel.
5. Blind stile chisel, with removable cutters.
6. Hollow chisel, for making sash and door pins.

Corner chisel (not shown).

Fig. 1766.



Mortising Chisels.

Mor'tis-ing Ma-chine'. Mortising machines are divided into *reciprocating* and *rotary.*

1. Reciprocating: —

a. Graduated Stroke. The chisel bar has a graduated reciprocating motion commencing from a still point, and progressing downward into the timber, returning to the starting point at each return stroke. This differs from a variable eccentric inasmuch as it requires a stroke but little longer than the depth of the mortise.

Variable cranks and eccentrics that operate the chisel-bar by an increased throw in both directions, also come under this category.

b. The chisel has a continuous motion, and the reciprocating parts, including the crank wheel, chisel-bar and connections, are brought down towards the timber, the chisel having a continuous motion, with a uniform range and positive eccentric.

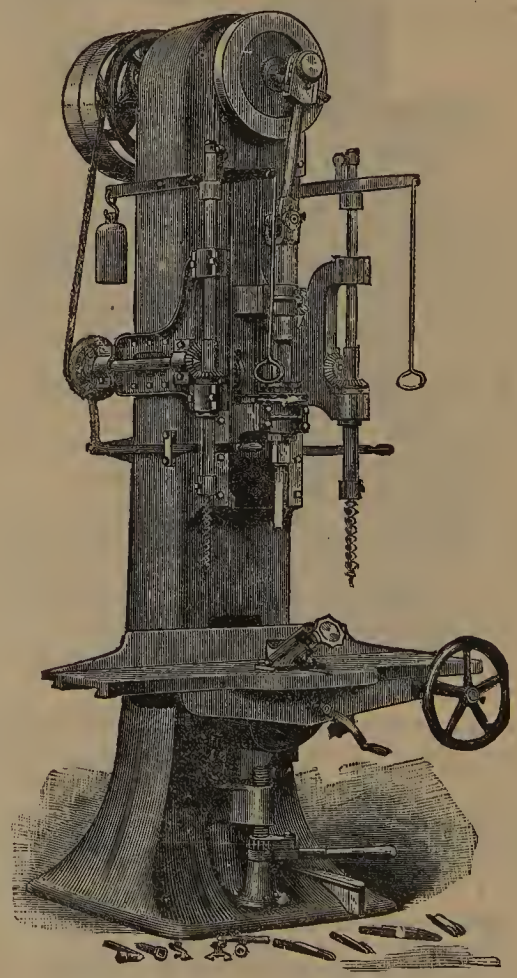
c. The chisel-bar or its connection is elongated to give the stroke, the bar and chisel having a continuous reciprocating motion, but capable of being extended to the required depth of mortise.

d. Machines in which the wood is moved up to the chisel, which has a continuous reciprocating motion. The latter is the most simple when the work is light.

2. The European machines are usually rotary, the action being a species of routing, the auger cutting on the side.

The car mortising and boring machine of *H. B. Smith* is shown in Fig. 1767. It has an auxiliary boring attachment,

Fig. 1767.



Reciprocating Car-mortising Machine.

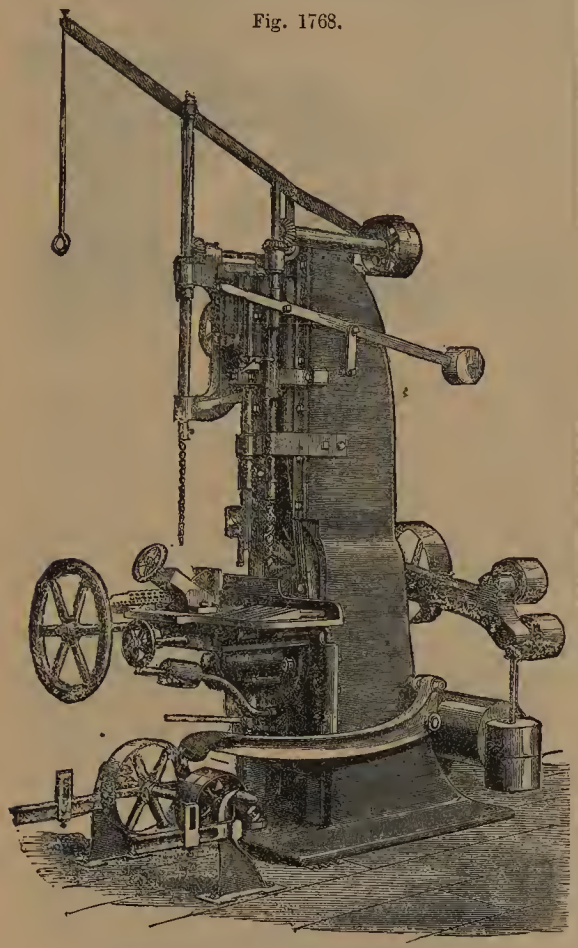
and is intended for car and other heavy work, being capable of making a 2½″ mortise through 12″ × 12″ stick of timber.

The head-stock, carrying the crank-shaft and chisel-bar, is fed down to the work by power, and has a quick return movement. Power for this purpose is taken from the crank-shaft, a lever at the base of the machine serving to apply the power for starting a screw in either direction for raising or lowering the head stock. The head-stock is stopped auto-

matically when it reaches its highest point, and an adjustable cam is provided for limiting its downward motion; so that the chisel may be made to penetrate any desired depth to 6″, an index on the frame showing to what depth it is cutting.

The table is adjustable vertically by means of a powerful screw and double ratchet lever. A rack and pinion feed is

Fig. 1768.



Reciprocating Car mortising Machine.

provided for moving the lumber horizontally under the chisel, an adjustable clamp holding it securely to the table. The table also adjusts to and from the machine and tilts for bevel work.

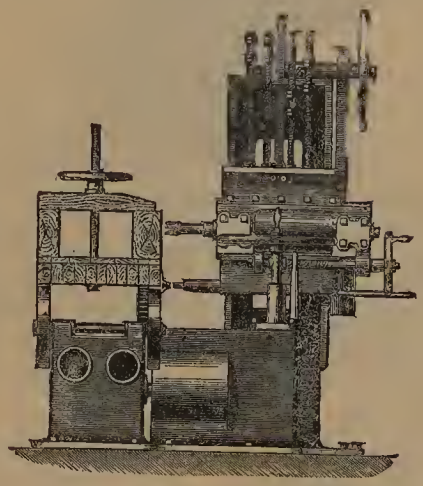
The reciprocating mortising machine of *Richards, London, & Kelley* is shown in Fig. 1768. It has also a boring spindle and auxiliary boring attachment for joint bolt-holes. It is a strong, heavy machine, especially adapted for railway-car work and similar duty. It receives chisels to any width, and has two boring spindles, one fixed and the other to traverse 12″. The feed movement is operated by treadle, and may be locked to avoid jarring the foot of the operator. The joints are compensating and operated without noise. The crank-shaft is placed in the base of the column, and the machine stands upon its base without top bracing.

See also HUB-MORTISING MACHINE, Fig. 1391, p. 472, *supra*.

Figs. 1769, 1770 are respectively side elevation and transverse vertical section of one of the rotary chisel class of mortising machines built by *Richards, London, & Kelley*, and adapted for boxing, facing, recessing, and mortising.

In machines of this class no laying out of the work is needed. A templet is placed upon the machine, and the stops are set for the position, length, and width of each mortise; after which any number of pieces are worked with-

Fig. 1770.



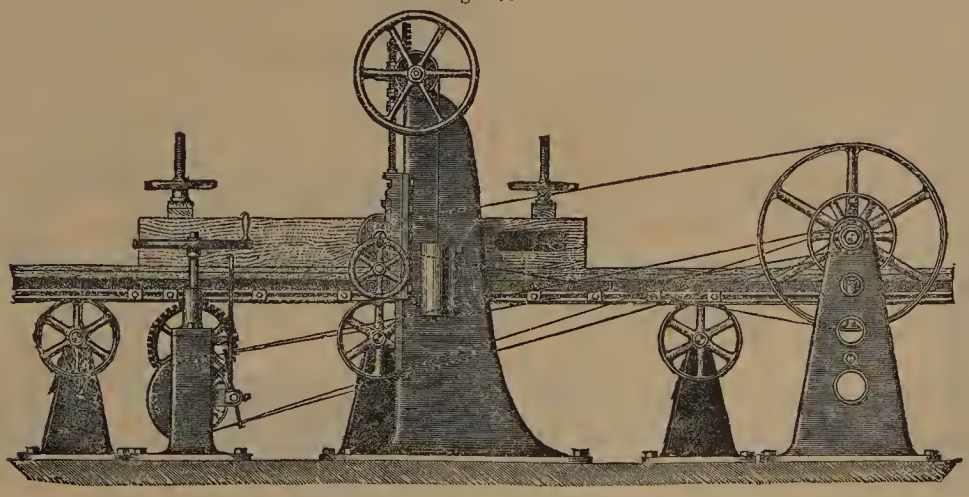
Rotary Chisel Mortising Machine. (Transverse Vertical Section.)

out a single mark of any kind on the timber, and without any danger of mistakes. The boxing, or facing, can be done at the same time, and with the same tools.

Fig. 1771 is an end elevation of another machine of this class, built by Ransomes (Br.). The work is clamped in a carriage which has a longitudinal reciprocation on ways for length of mortise The chisel is a router with side-lip, and the chisel spindle passes through the driving pulley, which is splined thereon. The motion of the timber carriage is by means of the lever, which is shown erect in the view, and that of the chisel is effected by the hand-wheel which is brought conveniently near to the work.

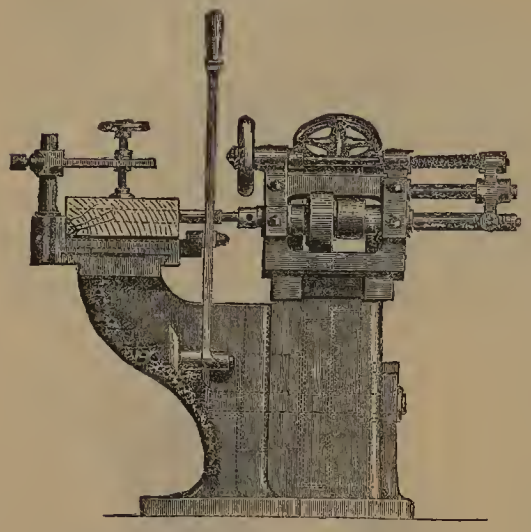
Fig. 1772 shows a combined mortising and tenoning machine. The work is dogged, as in the last-mentioned example, to a bench, which has, however, in the present case, an adjustment in either of two directions, longitudinally or transversely; the latter for the especial purpose of bringing the work within the range of the rotary tenoning cutters.

Fig. 1769.



Rotary Chisel Mortising Machine. (Side Elevation.)

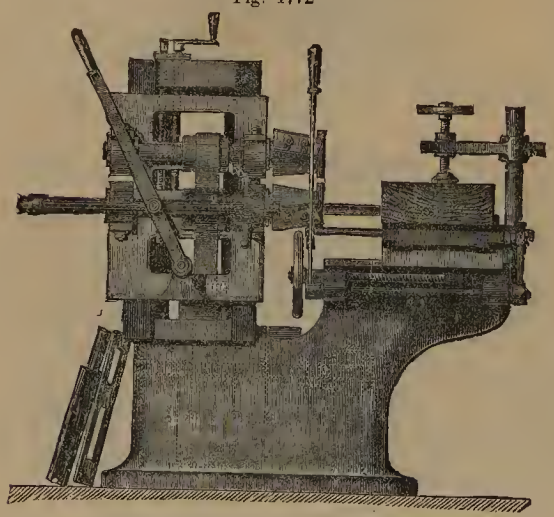
Fig. 1771.



Horizontal Mortising Machine. (*Rotary Movement.*)

These rotate on horizontal spindles in the upright frame, being capable of a movement of vertical translation to adjust their distance apart for making tenons of varying thickness. The lever shown in front is that by which the chisel is projected and withdrawn. The lever on the right of the one mentioned gives the longitudinal traverse of the carriage for length of mortise; or, for traversing the work past the tenon cutters, as the case may be.

Fig. 1772



Combined Mortising and Tenoning Machine.

See: car, *Lane & Bodley* * "*Engineer*," xli. 450.
And boring, *Goodell & Co.* * "*Manuf. and Builder*," viii. 57.
Robinson, Br. . . . . * "*Engineer*," xlv. 276.
And tenoning, *Carter*, Br. * "*Engineer*," xlii. 258.
Car, *Ransome*, Br. . . * "*Engineering*," xxvi. 174.
Green . . . . . * "*Scientific American*," xxxix. 311.
Smith . . . . . * "*Scientific American*," xxxv. 114.

Mo-sa'ic Gold. 1. A yellow metal for cheap jewelry. A factitious gold. See recipes, MOSAIC GOLD, p. 1484, "*Mech. Dict.*," and ALLOYS, JEWELERS, p. 63, *Ibid.*

2. A sulphuret of tin used in bronzing frames and as a gold color for printer's work. Two recipes for the dry process are: —

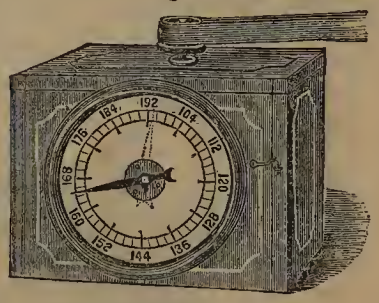
Tin foil	40
Sulphur	35
Sal ammoniac	25
Zinc putty	80
Sulphur	60
Sal ammoniac	30

In the wet process a solution of chloride of tin is treated with sulphureted hydrogen gas.

Moth'er. The hen-mother at Baker's Cresshill poultry farm is of hollow zinc, filled with hot water and lined on the under side with blanketing.

Mo'tion In'di-ca'tor. An apparatus to indicate upon a dial the rate of revotion — per minute, for example — of the machine to which it is attached. It does away with the element of time in observation, in this respect differing from the mere *counter*. The finger on the dial stands at the figure representing the beats per the unit of time for which it is calculated and constructed. Fig. 1773 shows the Bowsher motion indicator.

Fig. 1773.



Motion Indicator

See's motion timer, a modification of the metronome, * "*Scientific American Supplement*," 181.

Mo'to-graph'ic Re-ceiv'er. An invention of Edison, by which the volume of sound is increased in a telephonic receiver.

Called also ELECTRO-MOTOGRAPH, which see.

The vibrations of a mica diaphragm are communicated to a metallic rod, one end of which rests on a revolving cylinder with a chemically prepared surface. The contact of the cylinder and rod gives rise to friction which draws upon the diaphragm, but when an electric current passes, the friction is lessened and the diaphragm moves towards its normal position.

The current is governed by the sound waves and the motion of the receiving diaphragm also, and thus the sound waves are reproduced by the receiving instrument in augmented force.

See ELECTRO-CHEMICAL TELEPHONE, Figs. 947-950, pp. 305, 306, *supra*.

See * "*Engineer*," . . . . . Nov. 23, 1877.
* "*Engineer*," . . . . . xlvii. 213.
* "*English Mechanic*" . . . . . xxv. 276.

Mo'to-phone. A name given by its inventor, T. A. Edison, to a small machine driven by the voice. The phonographic vibrations of a diaphragm are caused to rotate an axle by means of a stylus and ratchet wheel.

Mo'tor. A prime mover. An engine. See under various heads: AIR; STEAM; ELECTRO; HOT-AIR, etc., etc.

See: Small "Simplex."
Davey, Br. . . . . * "*Engineering*," xxx. 251.
Hydr. steam, etc., *Knecht*. * "*Scientific American*," xli. 278.
Transmitting, paper on.
Robinson, Engl. . . "*Scientific American Sup.*," 1073.

Mo'tor Print'er. A small electro-motor running a press for copying messages. An electro-motor printer. "*Scientific American Sup.*," 367.

Moul'le-ton. (*Fabric.*) A fine wool French dress goods, with a satin weave.

Moun'tain Gun. (*Ordnance.*) A light cannon capable of being transported on mule back. For this purpose it is detached from its carriage and the weight distributed among several animals.

The Ashantee gun is shown in Fig. 3242, p. 1485, "*Mech. Dict.*"

The new Woolwich mountain guns, made from the designs of Sir William Armstrong, instead of weighing merely 200 lbs., like the mountain gun used in Abyssinia and Zululand, will weigh 400 lbs. each. As, however, an essential condition of mountain artillery is that every part of it shall be carried on the backs of mules, these guns are made in two pieces, screwed together, and strengthened at the joint by a

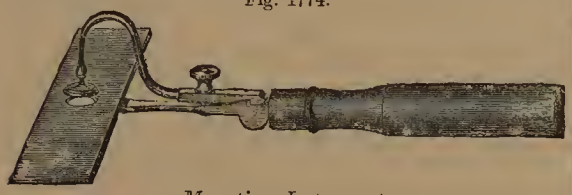
third piece in the shape of a ring or collar. The breech end of the gun when disjointed weighs 200 lbs., and the barrel with collar amounts to about the same weight, which is regarded as a fair burden for a mule over hilly country. These guns, like their smaller namesakes, are of the small caliber adopted for 7-pounder projectiles, but their greater length and weight enable them to do much more effective work.

* "*Scientific American Sup.*" . . . . . 2521.

Moun'ted Pow'er. A horse power adapted to be used without dismounting. See HORSE POWER.

Mount'ing In'stru-ment. (*Optics.*) An instrument for pressing down glass covers on microscope slides.

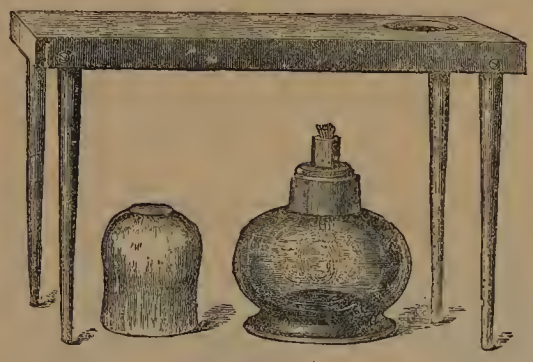
Fig. 1774.



Mounting Instrument.

Mount'ing Stand. (*Optics.*) A small table sliding up and down on a brass rod or stand, or independently on its own legs, and supplied with a chamber below for holding sand for equalizing the temperature when the lamp accompanying it is applied beneath. The stand shown in Fig. 1775 has folding legs, so as to go in a microscopist's traveling case.

Fig. 1775.

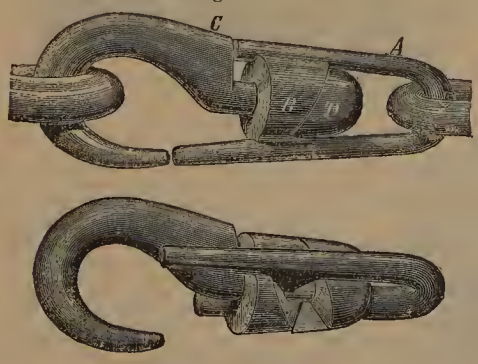


Mounting Stand.

Mouse Mill. A small electro-magnetic engine and electro static induction machine used in the siphon recorder. *Sir William Thomson, "Journal Soc. Teleg. Engineers,"* * v. 185.

It is propelled by a battery and its purpose is two-fold: (1) to generate statical electricity by means of induction wherewith to highly electrify the ink so that it may flow through the delicate capillary siphon pen. To generate the necessary electricity the drum is caused to rotate by electro-magnets, and this rotation is taken advantage of to (2) draw the paper past the point of the siphon.

Fig. 1776.



Self-locking Hook.

Mous'ing Hook. A hook having a member which normally closes the opening.

In the *Raines* mousing hook a draft upon the hook brings the mousing-arm in apposition with the point of the hook. The parts *B D* slide on each other, being respectively attached to *A* and *C*. The cut shows the device closed and open.

Mousse-line'. (*Fabric.*) A fine wool French goods, taffeta woven. *Moulleton* is woven with a satin armure.

For muslin see "*Report of East Indian Section*," Paris Exposition," p. 84.

Mousse-line' de Bége. (*Fabric.*) A French dress goods.

Mousse-line' Glass. (*Glass.*) A very thin blown-ware with ornamentation resembling the patterns of lace or printed goods.

The process is as follows: —

After carefully cleaning the surface of a plate of glass, an even layer of vitrifiable color is laid over it, with the aid of gum water. The glass is then submitted to a gentle heat until the water has evaporated, when a stencil of the desired pattern is laid over the surface, and with a stiff brush the pigment is removed from the parts which are to be transparent. The glass is next inclosed in a frame, and above it is extended a piece of tulle, or, if desired, embroidered lace, the embroidery in the latter case being so disposed as to harmonize with the ground pattern previously made. The whole is then hermetically closed in a box which contains in its lower portion a reservoir holding a certain quantity of dry color in the form of an impalpable powder. This is blown evenly upon the glass by an air-blast, adhering to it wherever the surface is not protected by the threads of lace. In this way the pattern of the latter is defined. In order to fix the powder the sheets of glass are exposed to steam, which moistens the gum and causes the powder to adhere. The color is then burnt in a special furnace. — *M. Aubriot.*

Mousseline glass was exhibited in Paris in 1878, in great beauty and variety by the "*Cristallerie de Clichy*," and by *Bandoux*, of Lodelinsart.

Lockert, on . . . . . "*Technologiste*," xl. 51.

Mous-tache' Pro-tect'or. 1. (*Dentistry.*) A shield to keep the moustache out of the way of the operator during operations on the teeth.

2. A shield on a drinking cup, to keep the moustache from dipping in the liquid.

Mouth Gag. (*Surgical.*) For holding the mouth open during operations. *Speculum oris.*

Fig. 1777.

Dr. Weir's Mouth Gag.

Dr. Weir's gag has two leaves with a spring catch. It is operated by two detachable handles. The illustration shows all parts and positions. See GAG, and references *passim.*

Fig. 1778.

Conn's Mouth-piece.

Mouth'ing Machine. (*Sheet-metal Working.*) A machine for crimping bottoms and swaging or mouthing the tops of open-top cans, to receive the covers.

Mouth Mir'ror. (*Dentistry.*) A small mirror to introduce into the mouth, to enable the observation of parts which have a rear presentation.

Mouth Piece. The lip of a wind instrument. That shown in Fig. 1778 is so constructed as to enable the performer to enlarge or contract the opening in the throat,

or bottom of cup, at will, while playing, thus facilitating the reaching of the higher notes, and requiring less pressure of the lips to produce them. It has two metallic pieces with an interposed elastic ring.

Mov'a-ble-back Saw. A saw, the stiffening back of which can be removed so as to convert it from a tenon saw to an ordinary hand saw.

Fig. 1779.

Hand Saw, with Movable Back.

Mov'a-ble Dam. A barrage.

The Davis Island Dam, on the Ohio, near Pittsburg, is the first attempt to introduce the *movable* dam system into this country. The system is known as the *Chanoine*, and is in use on the rivers of France, especially the Seine and Loire. It consists of a dam formed from wickets, and so arranged that when the water is high the wickets are lowered, and boats can pass over the dam freely. When the water is low the wickets are raised, a pool is formed, and the boats pass through the locks. See BARRAGE, *supra*.

The entire length of the dam is 1200′, and two stone piers divide this into three sections of 400′ each. That section nearest the lock is called the Pass, and this, besides the other two sections, is to be closed by the movable wickets whenever the stage of water in the river is less than 6′. Each wicket is a little dam by itself, hinged so as to lift up and oppose the water, or lie down and permit the river to flow over it. Each wicket is 13′ long and 3′ 8″ wide, made of oak. They are to stand on end, side by side, across the river, with a space between each of 4″. One by one they are raised, and when raised, they are retained in rigid position by the pressure of water above and a wrought iron prop below, until a *tripping bar* is brought into play and the entire dam falls down flat on the sill.

The lock has a clear length of 600′ between the gates, and a clear width of 110′, and can hold 12′ depth of water. The gates that shut off the water at either end of this lock are each in one solid piece, 118′ long, 10½′ wide, 14′ high, and weigh 80 tons. The openings in the lower part of the gate recesses, and for filling and emptying the lock, are 4½′ in diameter. The filling culvert, a lofty, arched water-way, takes the water from these openings and conducts it to the lock, which is filled through 10 inlets, each 3′ × 3½′, and 17′ below the coping. The lock has required over 11,000 cubic yards of cut stone and rubble, and 10,000 barrels of hydraulic cement.

The gates of the lock slide back into the gate recesses in the shore wall, and when in position across the lock, rest on a shoulder built in the river wall. They are operated by turbine water wheels. It is estimated that the gates can be closed or opened, and the lock filled or emptied in four minutes.

Description of the new system of wickets adopted for the La Mulatière dam on the Saône, at Lyons, by A. Pasqueau, Engineer des Ponts et Chaussées. Translation in "*Report of Chief of Engineers, U. S. Army*," 1880, * ii., pp. 1753–1762.

See also the same for 1879, * ii., p. 1338.

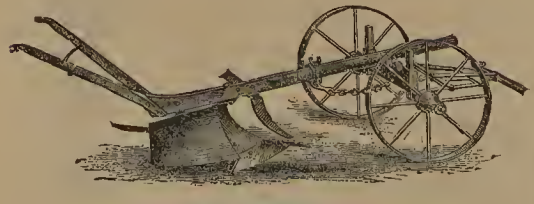
The movable dam at Poses, France, on the system of M. Camêré, is shown in the last-mentioned report, * p. 1342.

See BARRAGE, p. 76, *supra*, and Plate IV., opposite said page.

At Port-à-L'Anglais, on the Seine. "*Report of Chief of Engineers, U. S. Army*," 1876, Appendix R, * p. 14 *et seq.*: in connection with the works on the Davis Island dam on the Ohio.

French . . . "*Van Nostrand's Magazine*," xxii., 11.
Poirée system * "*Van Nostrand's Magazine*," xviii., 339.
Chanoine . *Ibid*, xviii., 459-481.

Fig. 1780.



Movable Point Plow.

Mov'a-ble Point Plow. One which has a long bar the forward end of which forms the plow-point, and can be thrust forward as it becomes worn. Made by Guilleux, Segré, France.

Mow'er. The subject of mower has been considered and the history detailed on pp. 1487–1493, "*Mech. Dict.*" Plate XXX. has diagrammatic views of 40 principles of cutting; and Plates XXXI.–XXXIII., have 36 illustrations. The classification of mowers is given on p. 1488, *Ibid.*

The McCormick iron mower is shown, in company with the McCormick single-wheel reaper, in Plate XXX. opposite. The mower is a front cut, jointed bar, iron frame machine, with inclosed gearing. The smaller size, 4′ cut, weighing 580 pounds.

The frame is of cast and wrought iron, and the gearing inclosed in a cast-iron case. The draft is directly upon the cutting apparatus through a draft-rod connecting the double-tree strap to the finger-bar brace. The cutter-bar has a rolling motion given to it by a roller on the end of the long connecting pin, which works up and down in the front end of the inside shoe; by this device the bar conforms itself to the unevenness of the ground, and always cuts a close stubble.

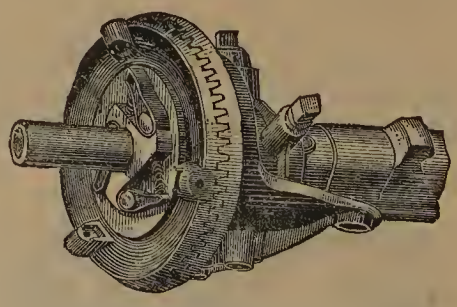
By means of the tilting lever, the points of the guards can be thrown up or down; and with the lifting lever the bar may be raised bodily from the ground, in order to pass over rocks or other obstructions; thus, through these two levers, the cutting apparatus is entirely under the control of the driver, and may be instantly changed, as occasion may demand, to suit the necessities of grass or ground.

The pitman box is light, strong, and durable; has no bolts, and yet can be quickly taken off and put on; the wrist pin has a screwed cover; the crank shaft box is bored large, so that a babbitt metal bushing is inserted, in which the shaft works; when worn, the bushing can be easily removed and replaced by a new one.

The Whiteley machine, "New Champion," is shown in Figs. 1781–1783. It is a front-cut machine, in respect of the cutter-bar being in advance of the gearing and carriage portion. The peculiarity of the machine is in the gearing.

There are practically but two pieces between the axle and the knife, one being a small bevel cog wheel secured to the axle, and the other a similar wheel made to gear into the former. This second wheel, or disk, does not rotate, however, but being hung on what is called a gimbal joint, like a ship's compass, it begins, on starting the machine, a succession of rapid serpentine vibrations around the face of the other wheel, much as a dinner plate or coin will act when rung down upon a table; and an arm extended from this vibrating disk down to the knife, gives it the required rapid, reciprocating motion. There is only one rotating bearing besides the axle on the machine, and that is not a part of the movement proper, but belongs to a small fly-wheel, which only assists in giving the required regularity and

Fig. 1781.



"*New Champion*" *Mower.* (*Gearing.*)

steadiness of motion. There are always 11 teeth in contact, and thus the wear is distributed over a large surface.

The finger-bar is operated and controlled by two levers, one for foot and the other for hand, and by the use of these levers either end of the finger-bar may be thrown up at any angle or to a vertical position without throwing the machine out of gear or stopping the knife. The finger-bar may also be folded and secured for transportation by the driver without leaving his seat, and by the use of the tilting lever the height of cut may be changed and controlled instantly. By the use of this lever the cut may be lowered and the points

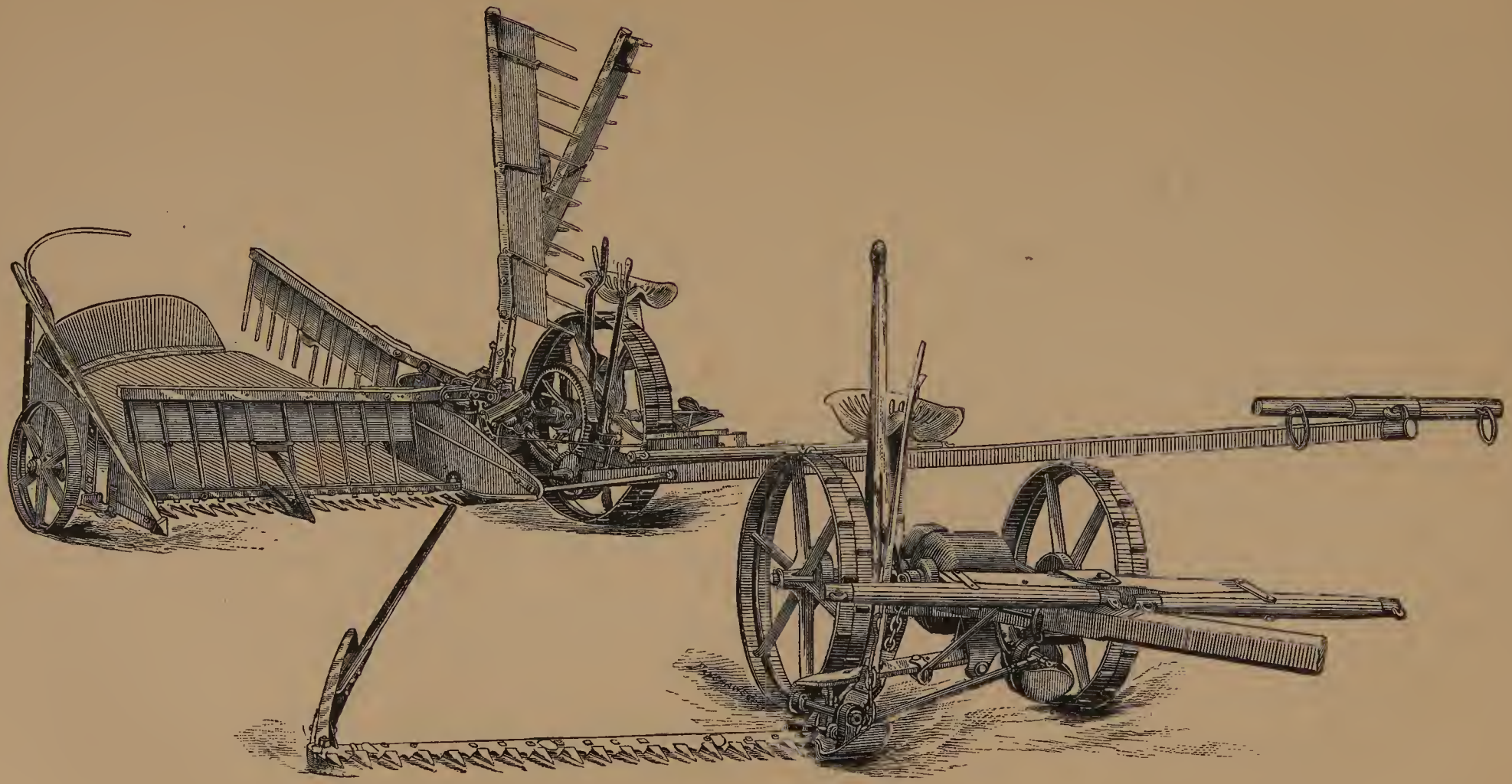
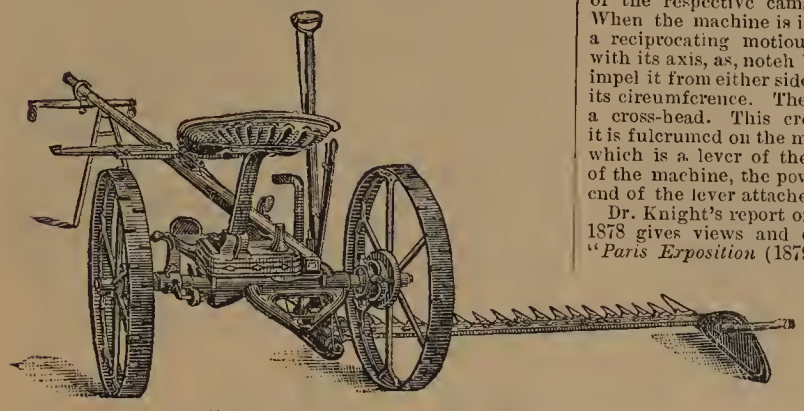


PLATE XXX. McCORMICK'S MOWER AND SINGLE-WHEEL REAPER. *See page* 620.

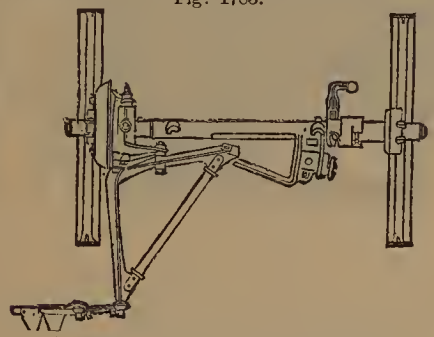
Fig. 1782.



"*New Champion*" *Mower.* (*Perspective.*)

of the guards turned down for picking up badly lodged grass, or the cut may be raised and the points of the guards turned up so as to cut high or readily pass over obstructions; or when desired, the tilting lever may be so arranged as to allow the finger-bar and guards to oscillate and perfectly follow the uneven surface of the ground. The gearing is inclosed within itself. The draft of the team is not upon the pole, but through a draft-rod directly connected to the

Fig. 1783.

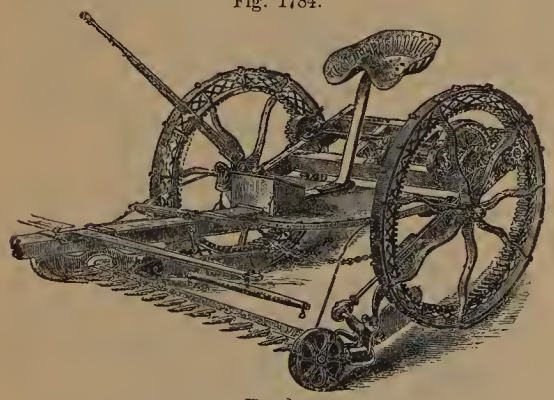


"*New Champion*" *Mower.* (*Plan.*)

cutting apparatus in such a way that a portion of the weight of the finger-bar is carried or suspended by the draft of the team.

Wilbur's "Eureka" mower is a direct draft front-cut, which cuts the grass behind the horses and in front of the running gears of the machine. One horse walks in the grass and the other upon the stubble, the double-tree being long, in order to throw one horse outside the swath, which is 6′ wide. The machine, being center-cut, is, of course, reversible, and may cut back and back, throwing the off and the near horse alternately upon the stubble.

Fig. 1784.



Eureka.

The peculiarity of the mowing machine motion of *Goodwin* is the method of converting the rotary motion of the driving wheels into the reciprocating movement of the knife without the intervention of spur gearing and without crank.

On the axle are two circular plates. These are fast to the axle, and have on their inner faces a series of inclined faces which may be termed *star-cams*. Between these two wheels is another *star-cam* which has faces on each side facing those of the respective cams between which it is sandwiched. When the machine is in motion the wheels rotate and give a reciprocating motion to the cam in a direction parallel with its axis, as, notch by notch, it slips past the cams which impel it from either side, all the faces bearing equally around its circumference. The cam is prevented from rotating by a cross-head. This cross-head is pivoted. At its butt-end it is fulcrumed on the main frame of the machine cross-head, which is a lever of the third order; fulcrumed on the frame of the machine, the power exerted by the cam and the outer end of the lever attached to the reaper knife.

Dr. Knight's report on Class 76 at the Paris Exposition of 1878 gives views and descriptions of the following. See "*Paris Exposition* (1879) *Reports*," vol. v., pp. 150-155: —

"New Champion" mower.
Whiteley . . . United States.
One-horse mower.
Walter A. Wood . United States.
"New Buckeye" mower.
Aultman & Co. . United States.
"Eagle" mower.
Wm. Anson Wood, United States.
"Paragon" mower.
R. Hornsby & Sons . . England
"La Française" mower, *J. Cumming* . . . . . France.

See also comparison of machines, Paris Exposition, *Knight*, "*Scientific American*," June 22, 1878.

For table of Dynamometrical tests, see p. 288, *supra*.

Mo'zam-bique'. (*Fabric.*) A French worsted dress goods woven on a gauze or taffeta loom. It has a cotton warp and an English combing wool weft.

Mu'ci-lage Brush. One with a reservoir in the handle, to keep the brush supplied.

Mucilage on government postage stamps: —

Dextrine	2 oz.
Acetic acid	1 oz.
Water	5 oz.
Alcohol	1 oz.
	9 oz.

Mucilage . . . "*Scientific American*," xxxv. 23.
"*Scientific American Sup.*," 2511
Bottle. *Wight*. . . * "*Scientific American*," xxxiv. 246.

Muck Iron. Crude puddled iron ready for the squeezer or rollers.

Mu'cy-line. A sizing for woolen yarns.

It is composed of 18 pounds stearine, 18 pounds of soft soap, 10 pounds glycerine, ½ ounce sulphate of zinc, and 50 pounds of water. The stearine is mixed carefully with the glycerine. The soap is then added. To this is added the water, in which the sulphate of zinc has been dissolved, amid constant kneading of the mass till a stiff and homogeneous paste is produced. For use, 32 pounds of this paste are taken and diluted with 36 pounds of water, which is used cold or warmed to 66° or 70° Fah., according to the season. The solution is filtered or clarified by decantation, and this clear liquid, which has a specific gravity of 1 025, constitutes the mucyline.

Mud'dler. A churning stick for chocolate. A smaller one for mixing toddies.

Muf'fle. (*Ceramics.*) A small furnace and chamber for baking metallic colors for pottery.

Fig. 1785.

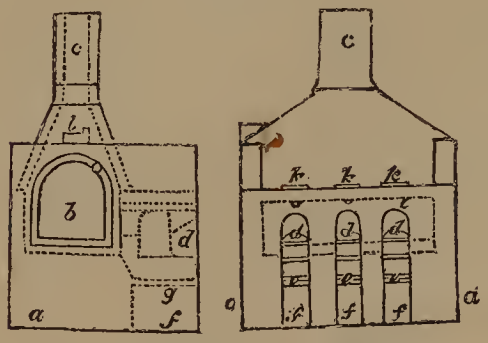
Mucilage Brush.

The figure shows two forms, one of them with a refractory clay chamber isolated from the fire. The other furnace has several chambers *d d*, with grating *e*, cinder holes *f f*, and openings *k k* to allow volatile matters to escape. See PORCELAIN MUFFLE, *infra*.

The other view has grating *g*, cinder hole *f*, charging hole *d*, muffle chamber *b*, escape for fumes *l*.

The fuel is exclusively wood or charcoal, the fire gentle at first and then intense. The heat is judged by practiced observation of the color of the fire or by the shades of color which the powder of cassius takes in the fire, being exposed on a removable slip of porcelain. See also PORCELAIN MUFFLE.

Fig. 1786.



Muffles for Vitrifiable Colors.

See: Fa"ence . . . . * "*Scientific American*," xl. 258.
For copper, *Silliman* . * "*Eng. & Min. Jour.*," xxii. 264

Muir'head Bat'te-ry. (*Electricity.*) A compounded Daniell's battery, in which the series of rectangular elements are inclosed in a tight box.

See Prescott's "*Electricity*," * p. 63; *Niaudet*, * p. 107.

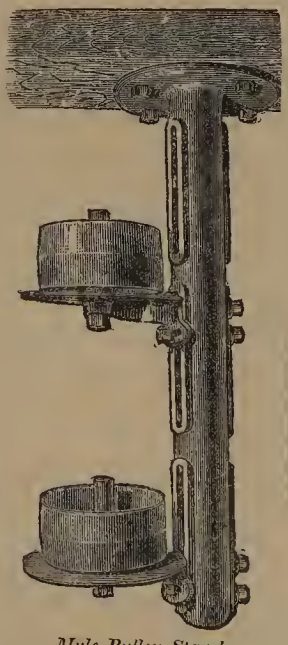
Mule. A machine for drawing and twisting into yarn the roving from the roving-frame or jack-frame and winding it upon spindles in the form of cops automatically.

These machines are in two principal parts, the stationary and the movable.

The stationary parts comprise the head-stock, creels, rollers, and roller-beams for reducing the thickness of sliver. The part called the head-stock contains all the mechanism for effecting the different changes necessary for spinning.

The English mules exhibited by Dobson and Barlow at Philadelphia, were for coarse and fine counts respectively. The coarse mule contained 216 spindles, $1\frac{3}{8}$" gage, and was arranged with double boss top rollers and single creels for spinning 1's to 50's. The fine mule contained 314 spindles, $1\frac{1}{4}$ inch gage, single boss top-rollers, creels for double roving, double speeds, supplementary stretch, roller turning motion to deliver yarn while twisting at the head-stock, faller motion to lift the fallers free from snarls, and is arranged to spin from 50's to 250's.

Fig. 1787.



Mule Pulley Stand.

In the headstock each motion is separate and distinct from the others; is so placed as to be easy of access, and can be detached and removed without disturbing the other motions. The headstock stands very low, which gives steadiness to the working parts, and enables a longer strap to be used, which is a special benefit in low mills.

The principal novelty in these mules is an improved method of working the changes, which dispenses with the well-known troublesome cam-shaft.

A long lever is placed lengthwise inside the headstock framing and makes three changes.

The first change is made when the carriage arrives out by lifting a latch lever, the long lever rises to a second latch and detaches the drawing out motion. When the requisite turns of twist are put in, the backing off takes place, and the locking of the fallers again liberates the catch and allows the long lever to rise again, putting out of gear the backing off and putting into gear the drawing-up cone. The mule recedes inwards to the beam, and the long lever is again unlatched and falls down to its original position, disconnecting the drawing-up motion, and putting into gear the drawing-out motion.

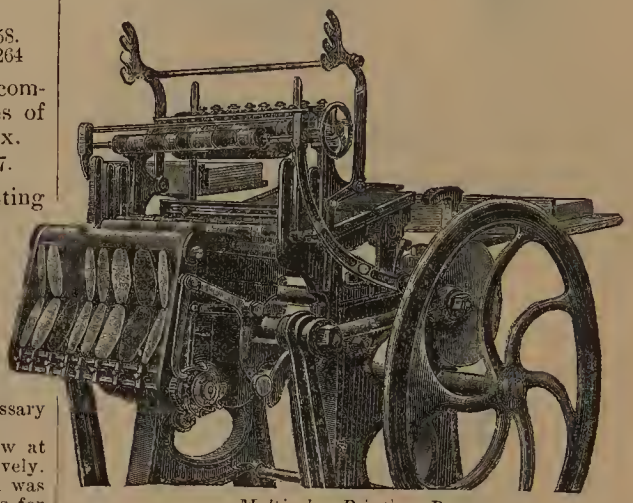
Lees, Br., "*Sc. Am.*," xxxvii. 211; *Spencer*, "*Engr.*," i. 437.

Mu'ley Axle. (*Railway.*) One without collars on the outer ends of the axle. See Axle Box.

Mule Pul'ley Stand. A form of stand for pulleys which revolve in planes at varying angles. In Fig. 1787, each pulley is on a plate which has a perfect adjustability on the post, either for height or for angle.

Mul'ti-coil Spring. One which consists of a number of coils as in *p*, *q*, *r*, *s*, *t*, *u*, Fig. 1143, p. 483, "*Mech. Dict.*," in contradistinction to a compound spring in which several types of springs are united for a simple effect, as in *k*, *l*, Fig. 1142; *m*, *n*, *o*, *q*, *r*, Fig. 1143; and *d*, *d*, Fig. 1144, p. 483. *Ibid.*

Fig. 1788



Multicolor Printing Press.

Mul'ti-col'or Print'ing Press. A chromatic printing press. Bacon's press, shown in Fig. 1788, is for printing in bands or stripes of color; not a press such as is used in chromo-lithography, for printing in over-laid colors by successive operations. See p. 545, "*Mech. Dict.*"

The working table, instead of being in a single piece, is composed of a number of narrow ovoid plates held in a frame, and so hinged as to move easily on each side at every revolution of the table. The end piece near the ink-trough is stationary. The various colored inks are placed in the ink-trough, which is divided into cells by metallic partitions. Directly over the trough is an iron frame carrying a set of screws and nuts. By tightening these screws, which are placed over the metallic partitions, the inks as they flow beneath are prevented from mixing. The inking rollers, instead of being fixed at a certain angle relative to the table, are arranged so as to run perfectly straight, the distribution being effected by a certain limited motion of the plates at each revolution. The different inks are spread on the multiple table in the usual way. Motion is communicated to the movable plates by a small lever which hangs under the table, and which rests on a small vertical iron plate affixed to a cross-stay of the machine.

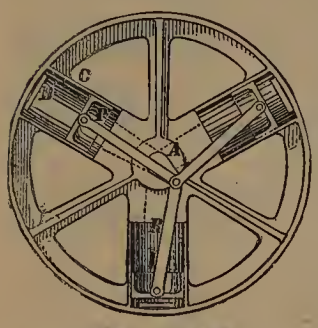
Mul'ti-cyl'in-der En'gine. A steam engine with a plurality of cylinders; the term is, however, rarely applied to engines with less than three cylinders.

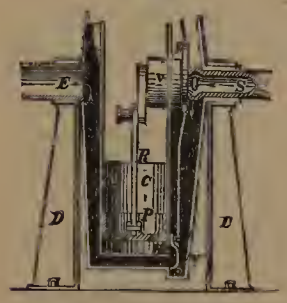
The Billing engine, shown in Fig. 1789, operates in a manner the reverse of that of ordinary motors, inasmuch as it is the engine that revolves while the shaft and crank are stationary. In the illustration three cylinders are employed, but as many may be used as can be grouped around the rim of the fly-wheel without causing too great complication of parts. Dead centers are avoided and the machine reduces itself to a self-rotating pulley-wheel.

A is the stationary crank, *C* is a light wheel, on which the three cylinders are grouped; the cylinders take steam at the rear end only, *B* being the steam-port and the dotted lines indicating the steam passages. The engine has bearings in the wheel-hubs, through one of which, *S*, the steam enters, as shown by the arrow, and through the other, *E*, the exhaust is had. The crank-shaft is merely a continuation of

the steam-pipe, a suitable stuffing-box being provided at *Y*. On the pipe, also, and inside the steam chamber is fixed the eccentric *F*, which gives motion to simple valves *B* at the cylinder ends. The exhaust-pipe may be run through a stuffing-box and used as a shaft for pulleys. See REVOLVING CYLINDER ENGINE, Figs. 4298-4301, p. 1931, "*Mech. Dict.*"

Fig. 1789.





Three Cylinder Engine.

See also SIX CYLINDER ENGINE; THREE CYLINDER ENGINE; also Fig. 890, Plate XI., op. p. 282, *supra*.

In the Payton & Holmes' multiple cylinder steam engine, (Br.), either two or four cylinders are used, the four cylinders being placed in pairs at right angles, one crank and eccentric answering for both. Steam is admitted only on the top side of the pistons of one pair of cylinders from the top port, and to the top of the other pair of cylinders from the bottom port. The engines can be reversed by a two-way cock for each pair of cylinders, placed behind the ports, and which, by moving a certain distance, reverses the steam current from the top of one pair of cylinders to the top of the other pair, or by sliding an inclined key fixed on a sleeve along the shaft within the eccentric.

Payton & Holmes, Br. * "*Engineer*," xlvii. 385.
Bacon . . . . . * "*Scientific Am. Sup.*," 349.

Mul'ti-flue Boiler. The horizontal multiflue boiler has its principal exemplars in the boilers of locomotives and portable engines. See Fig. 2927, p. 1346, "*Mech. Dict.*," Fig. 5638, p. 2329, *Ibid.*

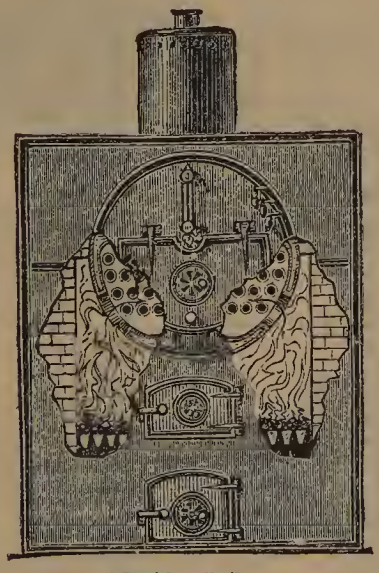
See also *A B C*, Fig. 5628, Plate LXI., "*Mech. Dict.*"

Observe the distinction between *flue* and *tube*.

The vertical multiflue boiler has flues or flame pipes traversing vertically the boiler space above the fire, being secured in their respective ends in the crown sheet or lower flue plate and the upper flue plate.

The *Lowe & Watson* multiflue boiler is shown by part elevation and part section in Fig. 1790. The furnace is beneath the front ends and the products of combustion pass from them by side openings into a combustion chamber which occupies a portion of the end of the boiler, then rearward by flues similar to those of a locomotive, and then beneath the boiler, and so to the stack.

Fig. 1790.



Multiflue Boiler.

SS. "Jason," *Cochrane*, Br. * "*Engineer*," xlix. 279.
Piedbœuf, Ger. . . . . * "*Engineer*," l. 228.

Mul'ti-fur'row Plow. (*Agric.*) One having several bodies for plowing two or more furrows at once. See GANG PLOW.

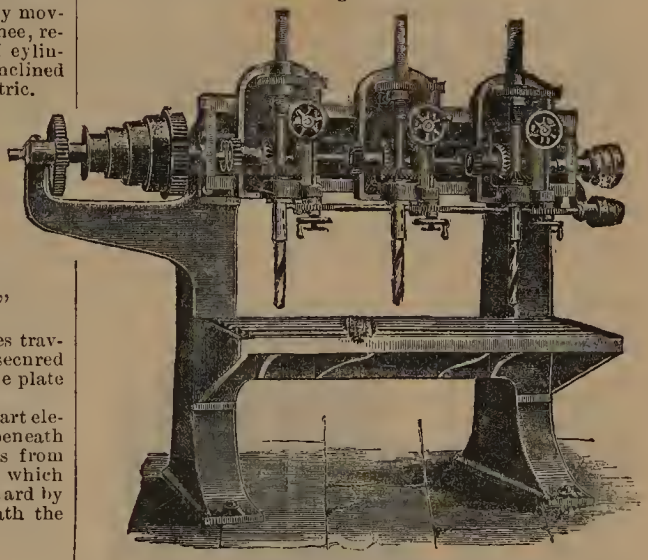
Mul'ti-ple Dril'ling Ma-chine'. A machine tool with a multiplicity of drills adjustable as to distance apart and adapted for drilling holes at a regulated distance apart on a number of bars which require exact conformity in all respects, as in bridge, trestle, and car work.

The London "*Engineer*" shows a machine especially adapted for drilling plates in position, on straight or hog-backed girders. The drills may be adjusted at any distance apart, and to suit varying pitches of holes, and while they may be brought together within $3\frac{3}{4}$", the driving wheels, by passing each other upon different levels, may be nearly 6" in diameter. The feed is automatic or independent at will.

See: *Buckton* . . . . * "*Engineer*," xli. 116.
Fetu & Deliège, Fr. . . * "*Engineering*," xxviii. 195.
Boring mach., *Richards* * "*Engineering*," xxvii. 506.

Mul'ti-ple Tel'e-phone. A form of telephone by M. Trouvé, intended to increase the capacity of the Bell and render it available for long distances. It has been adapted to M. Trouvé's military telegraph.

Fig. 1791



Multiple Drilling Machine.

"Instead of the single vibrating diaphragm used by Prof Bell, M. Trouvé substitutes a cubical chamber, each face of which (with one exception) is a vibrating membrane. Each of these membranes, being thrown into vibration by the same sound, influences a fixed magnet and electric circuit, the same as in the Bell arrangement. By associating all these currents, a combined current of single intensity proportional to the number of magnets influenced is produced. Instead of the cube, a polyhedron having an indefinite number of vibrating membranes may be used, and thus intensity augmented as desired.

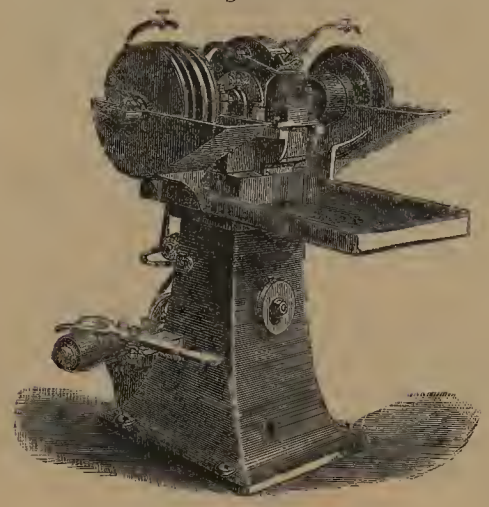
"Suppose now a line established on which is disposed a telephone constructed as above described, the membranes and magnets of which are divided into two series, and the circuits so arranged that, by pronouncing a word, currents are produced on the same wire in opposite directions. When a dispatch is received to be transmitted further on, the operator talks in the telephone in the usual way; and his speech, by the arrangement of circuits above noted, is heard both at the station to which he is forwarding the message and also at the one from which the message was sent, so that the possibility of error is thus rendered nil. M. Trouvé has adapted this apparatus to his military telegraph."

Mul'ti-ple Wheel Tool Grind'er. A grinding machine furnished with a variety of wheels, of differing qualities, fineness, size, shape, or what not, to suit varying requirements.

Fig 1792 is a tool grinder made with six emery wheels, by Thomson, Sterne & Co., of Glasgow, Scotland.

The wheels have different shapes and width of face, four being for gouges of varying size and for molding irons: one has a square face for straight edged irons (plane irons); one is a fine emery hone to replace the "water-of-Ayr" stone.

Fig. 1792.



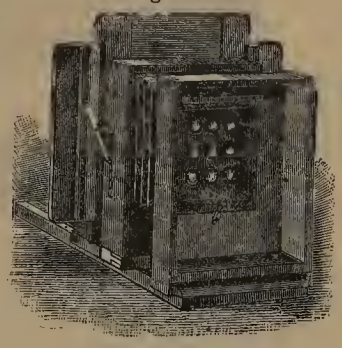
Multiple Wheel Tool Grinder.

It is especially designed for the use of joiners, pattern-makers, and other workers in wood. The water drip is from branches of a vertical pipe which rises behind the machine, the water being lifted by a small rotary pump driven by cord from the emery wheel shaft.

Mul'ti-pli-ca'tor. In *galvanometers:* a flat coil of conducting wire, for multiplying the effect of the current upon the needle.

That the needle tended to place itself at right angles to a galvanic current was the discovery of *Oersted;* that the effect was multiplied by increasing the number of convolutions of the conducting wire, was the discovery of *Schweigger.*

Fig. 1793.



Multiplying Camera Box.

Mul'ti-ply-ing Cam'e-ra Box. (*Photography.*) A chamber with numerous lenses all focalized by the same adjustment.

For instance the nine-tube multiplying camera box will take
72, 36, or 18 gems on a 7″ by 10″ plate.
9 on a 5″ by 7″ plate, and so on.

Mul'ti-tu'bu-lar Boil'er. One having a number of water tubes traversing the flame space.

A term unfortunately applied to those boilers having a number of small *flues* traversed by the flame and surrounded by water. For these, see MULTIFLUE BOILER.

The boiler is usually vertical; the water circulates through the tubes between the space above the crown sheet and that below the steam dome while the flames are beneath the crown and around the tubes and pass thence to the exit flue. See also from Figs. 56-9, to 5631, and Figs. 5634, 5635, Plate LXI., opposite p. 2326, "*Mech. Dict.*" Also see SECTIONAL BOILER.

Ormerod, Grierson & Co., Br. . * "*Engineer*," xlii. 379.

Mun'cke Bat'te-ry. (*Electricity.*) One in which the elements are of horse-shoe shape, one arm copper and the other zinc, soldered together at the bow. These are laid mutually interlocking on a frame which is lowered into the trough of acidulated solution. *Niaudet,* * Am. trans., p. 18.

Mur'rhine. The agate cups of the ancient Cambay and Broach in India. Glass, and glass vases, in imitation of murrhine vases, are cited by Arrian in his Periplus of the Erythrean Sea, as exported by the Egyptian traders to southern African Red Sea ports.

Mur'rhine Glass. (*Glass.*) An imitation in glass of the celebrated ancient drinking cups, made probably of onyx or agate.

The reference by Pliny, "*Album et murrhina aut hyacinthos sapphirosque imitatum et omnibus aliis coloribus*," is believed to describe the various kinds of glass so highly valued in his time.

At the Paris Exposition of 1878 were specimens of Roman murrhine glass, thus described: —

"There were silver goblets, or cups, with elliptical perforations half an inch long at the sides, through which an inner lining of sapphire or ruby glass protrudes like gems. The whole surface seems set with round cut and polished sapphires or rubies. The glass lining of the silver is perfect throughout, but bulges and protrudes through the openings. It is evident that the silver goblet is first made and polished, with the openings left in the sides, and then, being warmed, is lined with glass by blowing a bulb inside of it, the lining protruding through the spaces. These linings were, of course, very tight and close fitting, and could not be removed without breaking or melting the silver. These cups are copied from an original in the British Museum. Sapphires, emeralds, amethysts, and rubies were thus imitated.

"A cup in imitation of onyx — a copy of one in the treasury of St. Mark's — was mounted in silver gilt by Signor Castellani; another, also copied from one in St. Mark's treasury, and mounted in silver by Castellani, has the colors of topaz and emerald. A *paterœ* in murrhine colors, white, blue, and yellow, is a facsimile of the original in the National Museum at Naples." — *Prof. Blake.*

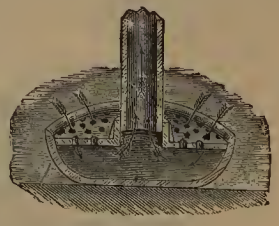
Mus'cle, Ar'ti-fi'cial. (*Surgical.*) An elastic caoutchouc band connecting two parts of an apparatus to draw them together, as in the case of club-foot apparatus, where a continuous strain is applied to correct deformity.

Mush'et Steel. (*Metallurgy.*) Steel made by fusing malleable iron with charcoal, graphite, or other carboneous matters in crucibles.

Mush'room. (*Electricity.*) An excrescence formed on the end of an electric-light carbon electrode. Such form from time to time, and becoming detached fall to the floor, or are caught in the glass globe. Also called *tack-heads.*

Mush'room Strain'er. An inverted dish strainer for cistern pumps, so named from its resemblance to a mushroom.

Fig. 1794.



Mushroom Strainer.

It will draw water from a level within 3″ of the bottom without disturbing the sediment. It screws on to the bottom of the pipe and is intended to rest on the floor of the cistern.

Mu'sic. See under the following: —

Agraffe.
Angelophone.
Autophone.
Bell.
Call bell.
Carillon.
Chimes.
Citole.
Clapper stay.
Clock-chime.
Cornet.
Diapason clock.
Gong.
Harmonic engine.
Harmonicon.
Harmonium.
Harp.
Horn.
Marimba.
Melodiograph.
Musical condenser.
Octave coupler.
Organ.
Organ blower.
Organ pipe.
Parlor organ.
Pedal.
Pianoforte.
Piano mover.
Pitch.
Reed.
Resonator.
Sounding board.
Tremolo.
Transposer.
Tuning fork.
Violin.
Xylophone.

See: block for printing.
Eckhardt . . . . . * "*Scientific American*," xxxv. 274.
Octave coupler . . . * *Laboulaye's* "*Dict.*," iii., ed. 1877, "*Orgues*," Fig. 3770.
Opera House, Paris . . * "*Scientific American Sup.*," 1501.
Paper punched for organ.
Needham . . . . . * "*Scientific American*," xxxix. 134.
Printing plates . . . "*Scientific American Sup.*," 1418.
Tone, Photography of.
Stein . . . . . "*Scientific American Sup.*," 958.
Condenser (telephone).
Varley . . . . . "*Scientific American*," xl. 6.
Musical tone telegraph.
Gray . . . . . * "*Scientific American Sup.*," 92.
La Cour . . . . . * "*Scientific American Sup.*," 145.

Mu'si-cal Con-den'ser. A sort of telephone, invented by Varley, for the conveyance of musical sounds. It consists of receiving and transmitting apparatus. See description in "*L'Electricité*," reproduced in * "*Scientific American*," xl. 6.

Mu'sic Print'ing. Alisoff's (St. Petersburg) method of preparing clichés for music is as follows: —

The staffs, notes, and all signs are printed on fine paper, and kept in cases, like type. A glass ruled with vertical and horizontal guide lines on the reverse side, is used on which to set up the music. The gum on the face of the glass renders the paper transparent, so that the guide lines can be seen. When a page is set up it is removed, and is reproduced by photographic relief process. The cliché is made much larger than the negative required, to give facility in setting and sink small inequalities by reduction.

Mus'lin Glass. (*Glass.*) French, *mousseline.* Glass blown very thin. See MOUSSELINE.

Muz'zle-piv'ot-ing Gun. A cannon which admits of firing through a very small embrasure, as the piece traverses upon a pivotal point at the muzzle.

Instance, Austrian piece, p. 537, and Fig. 43, Appendix I., "*Ordnance Report*," 1877.
Krupp . . . . . * "*Engineer*," xlviii. 122.
Eads . . . . . * Fig. 3411, p. 1566, "*Mech. Dict.*"

Muz'zle Sight. (*Rifle, etc.*) A front sight near the muzzle of the piece. It may be globe, open, etc. See list under SIGHT.

My'dri-a'sis Spec'ta-cles. *Mydriasis* is an exaggerated and chronic dilation of the pupil. Spectacles for its relief are blackened disks, pierced with small holes, which contract the area of light admitted. An affection just the opposite — the pupil being contracted to an exaggerated degree — is called *myosis.*

Fig. 1795.

Mydriasis Spectacles

My'o-graph. An instrument for recording muscular movement.

M. Helmholtz appears to have contrived the first instrument of this character. One end of a muscle of a frog he fixed to an immovable point, and the tendon of the other end to a lever whose movements, excited by electricity, were traced on a turning cylinder. See Fig. 1, p. 51, "*Scientific American*," xxxvi. 51.

M. Marey, in his myograph, has replaced the weight which was placed on the muscle by a spring. The registering apparatus is substantially similar to that shown in M. Marey's *cardiagraph*, which see.

For other physical recording apparatus, see PNEUMOGRAPH; SPHYGMOGRAPH; PLETHYSMOGRAPH.

* "*Manufacturer and Builder*" . xi. 205.
Laboulaye's "*Dict. des Arts*," *etc.* iv., cap. "*Graphiques.*"

N.

Nach'et's Prism. (*Microscopy.*) A means for throwing and revolving an oblique pencil of converging rays upon an object under examination by the microscope. *a* Fig. 3963, p. 1803, "*Mech. Dict.*"

Næ'vus Nee'dle. (*Surgical.*) A cauterizing dermal needle for obliterating a nævus or birth-mark. Heated by blow-pipe.

Nail. See, for history, and for list of varieties, pp. 1505, 1506, "*Mech. Dict.*"

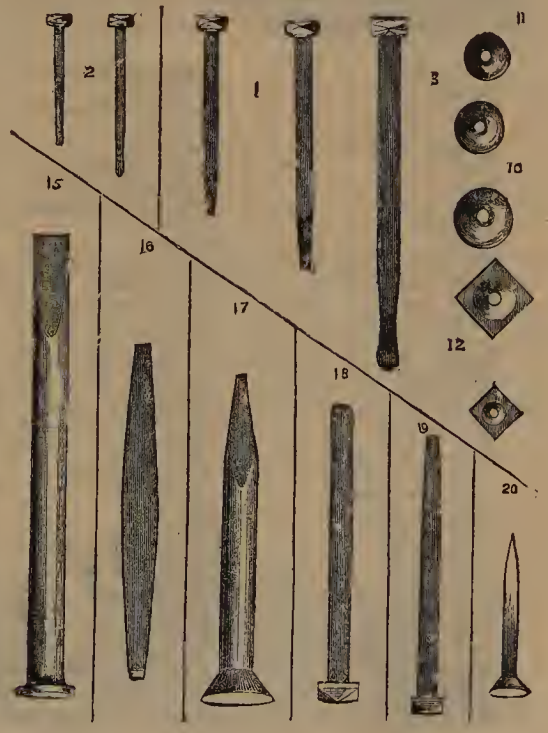
The Paris *pointes*, nails made from round wire, are now made channeled or polygonal by drawing or rolling. *Chelot.* The economy is 12 per cent. in material, and the efficiency is increased 20 to 35 per cent. according to the wood into which they are driven.

INDEX TO FIGS. 1796, 1797.

Wrought and Cut, Copper, Zinc, and Cast Metal Nails and Rivets used in Dockyards.

1. Rose-head copper boat nails (dumps or clench).
2. Rose-head copper flat points.
3. Deck-head copper flat points or spikes.
4. Cut copper clasp nails.
5. Cut copper brads
6. Cut copper rose-head boat nails.
7. Cut copper flat-head boat nails.
8. Wrought copper lightning-conductor nails.
9. Wrought copper stem nails.
10. } Copper rose-burrs or round roves.
11. }
12. Copper square roves.
13. Wrought copper clench nails, countersunk flat-heads, round points.
14. Wrought copper clinker nails and washers.
15. Cast composition butt bolts.
16. Cast composition dowels.
17. Cast composition stem nails.
18. Cast composition spikes or flat points.
19. Cast composition dumps or boat nails.
20. Cast composition sheathing nails.
21. Cast composition slating nails.
22. Wrought copper hose and strap rivets.
23. Tinned copper hose and strap rivets.

Fig. 1796.



Ship Nails.

Fig 1797.

Ship Nails.

24. Cut copper slating nails.
25. Cut copper or brass tacks.
26. Cut brass brads.
27. Cut zinc slating nails.
28. Wrought copper tacks.

The following varieties bear names indicative of material, application, shape, size, character of head, etc.

Band nail.
Barbed nail.
Barrel nail.
Basket nail.
Bessemer-steel nail
Black nail.
Blued nail.
Blunt nail.
Boat nail.
Brad.
Brass nail.
Brush nail.
Brush tack.
Card tack.
Carpet nail.
Carpet tack.
Casing nail.
Chair nail.
Channeled nail.
Channel nail.
Charcoal iron nail.
Cheese-box nail.
Chisel-point nail
Cigar-box nail.
Clasp nail.
Clinch nail.
Clinker nail.
Clout nail.
Coated nail.
Coffin nail.
Coffin-lining nail.
Collar shoe nail.
Concave-head nail
Conical nail.
Cooper's tack.
Copper nail.
Copper-plated nail.
Copper tack.
Countersunk-head nail.
Cut nail.
Cut tack.
Deck-head nail.
Diamond-head nail.
Double-pointed tack.
Drive nob.
Dump.
Escutcheon pin.
Felting nail.
Fencing nail.
Fine nail.
Finishing nail.
Flat-head nail.
Flat-head tack.
Flat nail.
Galvanized nail.
Gimp nail.
Gimp tack.
Glazier's point.
Hame nail.
Heel nail.
Hob-nail.
Hook-head brad.
Hungarian nail.
Japanned nail.
Lace tack.
Last nail.
Leathered tack.
Lightning conductor nail.
Lining nail.
Lining tack.
Looking-glass tack.
Machine finishing nail.
Miner's tack.
Nugget-head nail.
Oval-head nail.
Pail tack.
Picture-frame nail.
Plated nail.
Riveting knob.
Roofing nail.
Rose-head nail.
Saddle nail.
Serrated head nail.
Shank tack.
Sheathing nail.
Ship nail.
Shot-head nail.
Shoe nail.
Shoe tack.
Silver nail.
Slating nail.
Smooth nail.
Spike.
Steel nail.
Stem nail.
Swedes-iron nail.
Tack.
Tinned nail.
Tinned tack.
Tobacco nail.
Trimming nail.
Trunk nail.
Tufting button.
Tufting nail.
Twopenny to Twenty-penny.
Upholsterer's nail.
Upholsterer's tack.
White-metal nail.
Window-glass point.
Wire-nail.
Wrought nail.
Zinc nail.
Zinc-shank nail.
Zinc shoe nail.

See also: —

English hist. and meth. "*Scientific American*," xxxvii. 73.
Nail driver . . . . . "*Scientific Amer.*," xxxix. 280.
Nail driver (under water) * "*Mm. & Sc. Press*," xxxvii. 209.
Extractor, *Tinker* . . * "*Scientific American*," xxxv. 258.
Machine, self-feeding.
Grant . . . . . "*Iron Age*," xxii., Dec. 5, p. 7.
Haddock . . . . . * "*Iron Age*," xix., March 29, p. 9.
Forging machine, *Taylor & Challen*, Engl. . * "*Scientific Amer.*," xxxvii. 210.
Taylor & Challen, Br. * "*Engineering*," xxiii. 480.
Picker . . . . . "*Iron Age*," xix., June 7, p. 3.
Selector . . . . . * "*Iron Age*," xxii., Nov. 7, p. 1.
Works, Birmingham, England . . . . . "*Scientific American Sup.*," 89.

Nail Gun. A device for nailing down flooring boards.

The nail is placed on the end of a tube and a rod slipped down within drives the nail home.

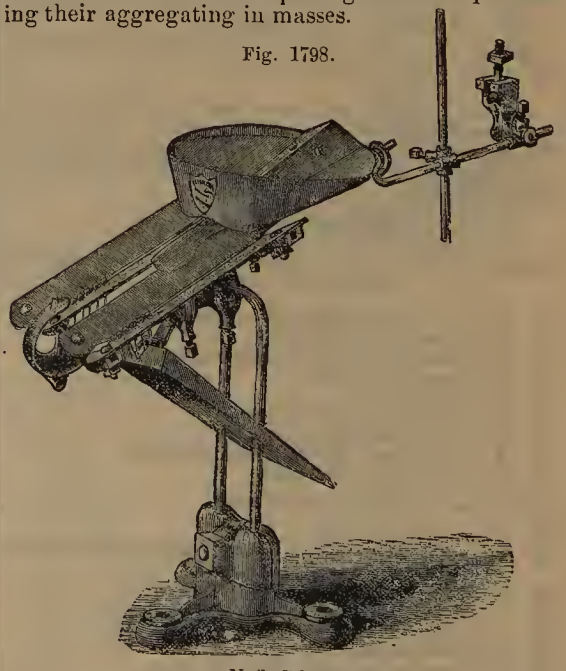
Nail In'stru-ment. (*Surgical.*) The list includes: —

Nail extracting forceps.
Sequestrum forceps.
Scalpel.
Nail cleaner and file.
Nail nippers.
Spring for inverted nails.
Splinter forceps.

It embraces the instruments of the chiropodist and the manicurist.

Nail Pol'ish-ing Ma-chine'. A tumbling box. A hexagonal chamber 19″ in diameter and 30″ long, with heads. In it the nails are placed and tumbled about against each other, points on the inside of the chamber displacing them and preventing their aggregating in masses.

Fig. 1798.



Nail Selector.

Nail Se-lec'tor. A machine, or an attach-

ment to a nail machine, to pick out perfect nails from headless and ill-formed nails, slivers, and first cuts.

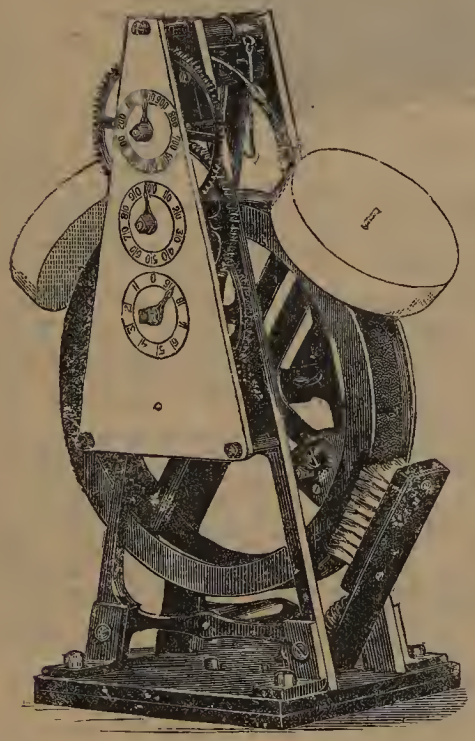
It consists of two pairs of parallel plates set at angles to each other and inclined to the floor, forming a sort of trough with a slot running the entire length of the plates. At the top and immediately under the hed plate of the nail machinery is a pan or receiver to catch the nails as they drop from the machine. The bucket is attached to the rear of the bed plate, while the upright rod is in the path of, and receives a stroke from, the griping lever. Thus every movement vibrates the selector and feeds the nails into these troughs, the plates of which are so set as to allow the points to drop into the slots, hut not to permit the heads to pass through; that is, the uails are held by their heads as they are conducted down the slots in Indian file. The dirt and headless nails and slivers fall through the slot under the machine, into a receiver, while the perfect nails, held by their heads, slip to the lower end of the trough where the slot expands to a large oval, allowing the perfect uails to fall into the pan for removal.

The same plan is used in machiues for feeding wood-screw-blanks.

Nap Me'ter. An instrument invented by Prof. Kittary and used for testing the wearing quality of cloth, by the Russian war office.

The instrument consists of a double-flanged wheel, faced with leather between the flanges, and having two rasps hung and weighted so as to bear upon that face; also an ordinary set of counting-wheels and dial-plates, to show the number

Fig. 1799



Russian Nap Meter.

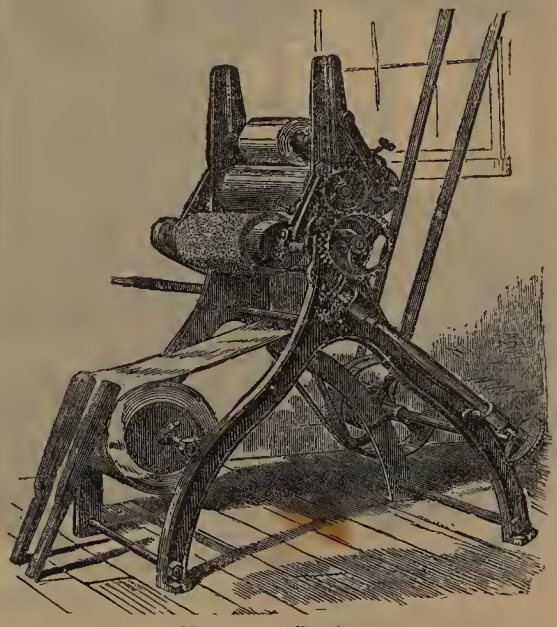
of revolutions of the flanged wheel. The cloth to be tested is wound in a narrow strip around the leathern face and secured, a light hrush is provided to remove the dust, the rasps brought to bear upon the cloth, and the number of turns of the crank required to wear the cloth threadbare and smooth gives a comparative test of its durahility aud wearing qualities.

Nap'per. A machine for cleaning, napping, and surfacing hosiery goods.

It consists primarily of a roller on which the goods are flatly stretched, and a hrush, consisting of card clothing, applied to the cloth. The machiue takes in auy width of cloth, from 24″ down, hrushes the cloth in a flattened web, works on both sides at once, cleans off the specks, burrs, seeds, etc., raises a nap, restores the pliancy and softness — of which the washing has deprived the goods — and leaves the web in a smooth roll ready for the cutter.

The goods are smoothly stretched both in length and width over a roller having a firm and true surface. The brush cards are attached to a wooden roller, the hearings of which are adjustable parallel with the cloth roller. A lever on the left allows the pressure to be relaxed when a seam occurs.

Fig. 1800.



Napper and Brusher.

Nap'ping Ham'mer (or *Knapping*). A stone-breaker's hammer, as for macadamizing, for instance.

Fig. 1801.

Napping Hammer

Naph'tha. A grade of petroleum obtained by distillation, and having a gravity from 65° to 62° *Beaumé*.

It may be considered the third in the series of products as practically utilized.

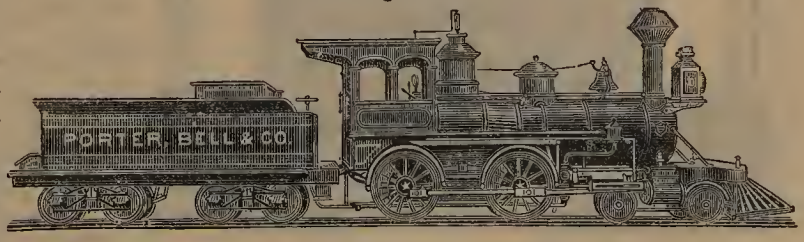
Gasoline, gravity 90° to 80° *B.*
Benzine, gravity 74° to 68° *B.*
Naphtha, gravity 65° to 62° *B.*
Kerosene, gravity 59° to 38° *B.*
See also KEROSENE; PETROLEUM.

Nar'row Gage Lo'co-mo'tive. Fig. 1802 shows a narrow-gage freight locomotive.

These engines are equalized between rear and center drivers: they also have a cross equalizer at front drivers. The ecuter drivers are without flanges. They are easy on the track, and curve well up to a speed of 15 to 20 miles per hour. Having all their weight on drivers, and a short wheel hase, they are specially adapted to hauling heavy loads on steep grades and short curves.

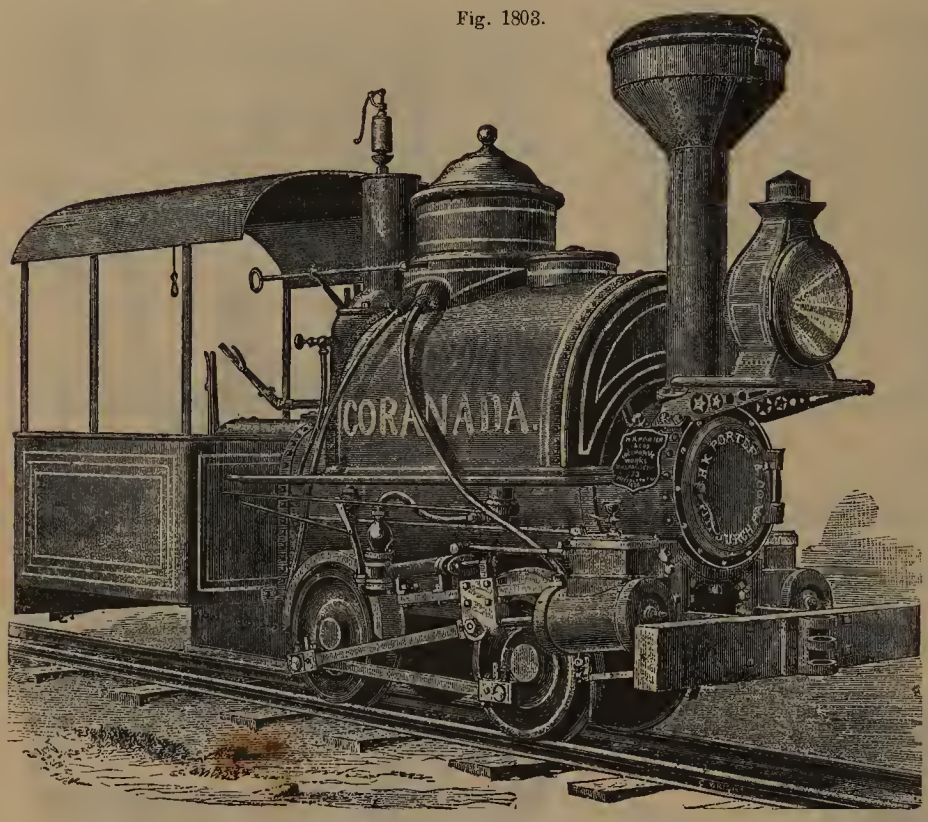
They are made of varying sizes and powers.

Fig. 1802.



Narrow Gage Freight Locomotive.

Fig. 1803.



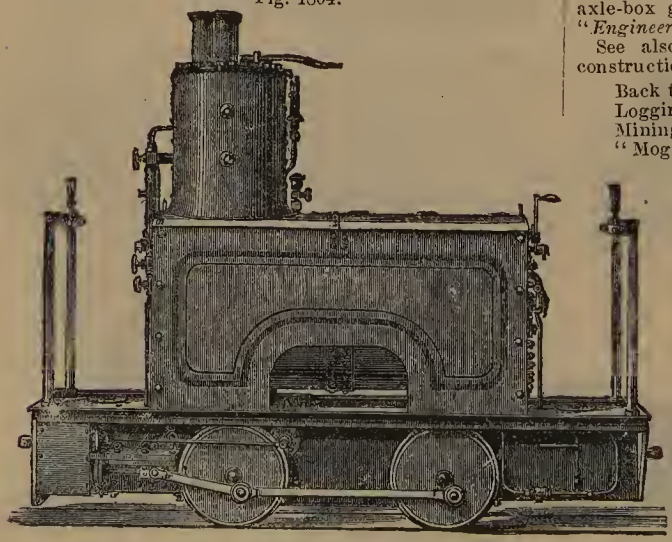
Locomotive for 20″ Gage Railroad. Arizona.

Cylinders, diameter	10″ to 12″
Stroke	16″ to 16″
Drivers, diameter	33″ to 36″
Wheel base	28′ to 29′
Weight working	28,000 to 36,000 lbs.

A locomotive for 20″ gage, built by Porter for the Longfellow Mining Company of Arizona, is shown in Fig. 1803. The following is a description: —

Gage of track	20″
Cylinders, diameter	6″
Stroke	10″
Wheel-base	45″
Diameter of boiler at smoke-box end	23″
Number of flues	29
Diameter	1¾″
Length	72″
Fire-box, inside measurements, length	28″
Width	19″
Depth	27⅞″
Driving wheels, diameter	22″

Fig. 1804.



British 18″ Gage Locomotive.

Water supplied by one full-stroke pump and one number two injector.

Tank capacity, 200 gallons.

Fuel, wood; fuel room for about one fourth of a cord of engine wood.

Weight in working order, about 9,000 pounds.

Extreme width over all, 65″ at back bumper, 46″ at cylinders.

Extreme height, 100″.

Extreme length, 158″.

Width in clear between frames, 13″.

Throw of eccentrics, 2⅜″.

The railroad is 5½ miles long, with maximum grades of 4½ per 100 and minimum curves of 90′ radius, with 16-lb. rails, and is used for the transportation of copper ore, the loaded cars coming down grade. The locomotive boiler is set on a slight incline, so that the water will be level when it is on an average grade, and the engine is intended to back up the grade. The locomotive was taken apart and boxed for shipment: as it had to be prepared for hauling by wagons several hundred miles from the railroad terminus. The frames, with cylinders and entire link motion, were all placed in a box about 8 × 4 × 3′, and weighed about 2,000 lbs.

Fig. 1804 shows a yard engine used on an 18″ railway in the Crewe Works of the London and North Western Railway, England.

The boiler is cylindrical, and is traversed by a hexagonal flue strengthened by small cross-tubes, which present very efficient heating surface. From the flue three chimneys pass up through the steam dome, each chimney being provided with its own blast nozzle. The flue is fixed on the barrel by bolted joints so that it can be readily taken out for cleaning the cross-tubes when necessary.

The cylinders are 5.5″ diameter, 6″ stroke; wheels 15″ diameter. The effective pull estimated at 1,089, steam being 90 lbs. A regulator handle as well as a reversing lever is provided at each end of the engine so that the latter can be driven from either foot-plate. The water is carried in tanks between the frames, and the boiler is fed by a simple kind of injector. The engine is carried on four cushion springs, which are simply placed in recesses cast in the top of the axle-box guide, and bearing directly on the axle-boxes. — "*Engineering.*"

See also other heads descriptive of special features of construction or adaptation: —

Back truck.	Plantation.
Logging.	Pony truck.
Mining.	Switching.
"Mogul."	Tank.

See: Billerica, track	*	"*R. R. Gaz.*," xxii 1.
Cars	*	"*R. R. Gaz.*," xxii. 50, 87.
Locomotives	*	"*R. R. Gaz.*," xxii. 11, 19.
Switches and frogs	*	"*R. R. Gaz.*," xxii. 65.
Ribeauville, Alsace	*	"*Sc. American*," xlii. 228.
Canada		"*Van Nostrand's Mag.*," xvii. 560.
Locomotive, Festiniog, R. R., Wales.	*	"*Sc. Amer. Sup.*," 1535, * 1619.
Progress		"*Sc. Am. Sup.*," 993.
Rostoken, Hungary		"*Van Nostrand's Mag.*," xvi. 475.
Hungary, etc.		"*Van Nostrand's Mag.*," xxii. 7.
Locomotive for India, British	*	"*Sc. American Sup.*," 835.
In India		"*Van Nostr. Mag.*," xv. 68.
General subject & statistics, *Morandière*		"*Van Nostr. Mag.*," xviii, 168.

The report of M. Jules Morandière shows that the narrow gages vary between 1.5′ and 6′, and

cites 20 different gages between these limits, in 17 countries. The following are the statistics of the narrow gage railways in 24 countries cited, at the date of the report (1878).

Name of Country.	Number of Miles.	
	Open to Traffic.	In Construction.
Great Britain	26	–
France	43½	89½
Algiers	20½	155½
Belgium	77	–
Norway	192½	–
Sweden	163	–
Russia	2 8½	–
Austro-Hungary	52¾	183¾
Prussia	20	–
Italy	7½	–
Island of Sardinia	18	–
Switzerland	22	–
Greece	5½	–
Portugal	–	–
India	820½	1,902
Australia	328	–
New Zealand	244	–
Cape of Good Hope	67	–
Canadian Dominion	457	373
United States	2,040	7,552
Central America	37¼	155
Venezuela	–	–
Peru	17¼	–
Chili	118	–
Bolivia	–	155
Brazil	20	411
Havana	–	–
Java	34	–

"*Mémoirs de la Société des Ingenieurs Civils*," 1878.

"On the Denver and Rio Grande Railroad it is stated that 16 cars on the 4′ 8½″ gage unload and fill 20 cars on the 3′ gage. Thus, say —

Empty Cars, Weight.	Paying Load.	Total Dead Weight.	Total Paying Load.	Total Cars and Load.
	tons.	*tons.*		
16 cars, wide gage, 8½ tons	10	136	160	296
20 cars, narrow gage, 5 tons	8	100	160	260
Saving in total weight	–	–	–	36 tons.

Which is equivalent to 22 tons additional freight, or 23 per cent. more, assuming the cars loaded to the full capacity, and the comparison is more favorable when the cars are not filled. — *Capt. Galton's* report, "*British Reports on Centennial Exhibition.*"

Na′sal Feed′ing Ap′pa-ra′tus. One of the alternatives in case of lock-jaw, mania, choking paretics, paralysis of the throat, fractured jaw, etc.

The nasal operation may be by a simple funnel, a tube in the pharynx, or a tube directly into the stomach.

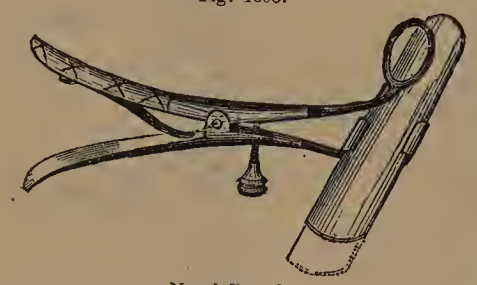
Dr. Newington's feeding device with two nasal tubes, used in Bethlehem Hospital, London, is described in * "*Lancet.*" See also * "*Scientific American Supplement*," 2648.

Na′sal In′stru-ments. (*Surgical.*) Includes the following: —

Nasal speculum.
Nasal douche.
Nasal clamp.
Epistaxis tampon.
Laryugeal syringe.
Posterior nares syringe.
Nasal electrode.
Polypus forceps.
Polypus canula.
Epistaxis canula.
Rhinoscope.
Rhinoscopic mirror.
Nasal syringe.
Nasal feeding tube.

Na′sal Spec′u-lum. A bivalvular speculum for distending the alæ of the nose.

Fig. 1805.



Nasal Speculum.

In Dr. Shurly's nasal speculum one valve is a ring; the other a shell; they are made in pairs, rights and lefts.

See also *a*, *b*, *c c*, Fig. 5361, p. 2260, "*Mech. Dict.*"

Na-trom′e-ter. An instrument for estimating the quantity of soda contained in salts of potash and soda. *Pessier* has invented a standard form.

Nat′u-ral Steel. (*Metallurgy.*) 1. Steel made directly from the ore by the *blomary* process.

2. Steel obtained by the finery process; the carbon being removed from the molten cast iron by a blast of air directed upon the metal, which is covered with a layer of charcoal.

Nau′ti-cal. See under the following heads: —

Anchor.
Anchor and cable, parts of, and appliances.
Anchor lift.
Anchor shackle.
Arm.
Bill.
Blade.
Bower.
Bull-rope.
Buoy rope.
Cable shackle.
Capstan.
Cat.
Cat back.
Clutch.
Compressor.
Controller.
Deck stopper.
Devil's claw.
Dog stopper.
Fish.
Fluke.
Forelock.
Grapnel.
Kedge.
Kevel.
Link.
Messenger.
Mooring swivel
Nippers.
Palm.
Passing nippers.
Pawl.
Pee.
Point.
Racking turns.
Ring.
Shackle
Shank.
Sheet anchor.
Slip stopper.
Spare anchor
Square.
Stock.
Stopper.
Stream anchor
Stud.
Swifter.
Swivel.
Throat.
Warping.
Whelps.
Wing stopper.
Anti-racer.
Arm.
Armor.
Armor compound.
Armor plate.
Artificer's knot
Back board.
Ball-joint hinge.
Beacon.
Bees.
Bench-hook.
Bench sail-hook.
Binnacle.
Block, varieties; see list under "Tackle").
Bouche.
Bushing.
Chaunel.
Cheeks.
Coak.
Gorge
Pin
Score.
Sheave.
Shell.
Strap.
Swallow.
Block-hook.
Boat.
Back-board.
Boat launching apparatus
Boat lowering apparatus.
Bottom board.
Canoe.
Cat boat.
Cat rig.
Center board.
Clamp.
Collapsible boat.
Davit.
Ducking boat.
Folding boat.
Gunwale.
Head sheet.
Ice boat.
Kyak.
Launch.
Launch engine.
Lazy painter.
Life boat.
Life raft.
Mast hinge.
Nautilus.
Oar.
Painter.
Poppets.
Portable boat.
Portable raft.
Rowing gear.
Rowlock.
Rudder lanyard.
Skiff.
Slings
Sneak box.
Steadying line.
Step.
Stern benches.
Stern sheets.
Stretcher.
Surf boat.

Thwarts.
Well sneak.
Yawl.
Boat hook.
Boat knot.
Boat launching.
Boat lowering apparatus.
Boat plug.
Boatswain's toggle.
Boat yoke.
Boom tackle.
Bouche.
Bower.
Bowline knot.
Bowline on a bight.
Bowline tackle.
Bowsprit shrouds.
Box.
Brace-block.
Breast rope.
Builder's knot.
Bull's-eye.
Buntline leader.
Buoy.
Bushing.
By-pass.
Cable shackle.
Calking-iron.
Canoe.
Cant splice.
Capshore.
Capstan.
Capstan knot.
Carrick bend.
Catamaran.
Cat boat.
Cat rig.
Center board.
Chain pipe.
Chain stopper.
Chain tag.
Channel.
Cheek.
Chock.
Cigar steamer.
Clamp.
Cleat.
Clew.
Clew-thimble.
Clove hitch.
Clutch.
Coach whip.
Coak.
Collapsible boat.
Collar.
Companion ladder.
Composite.
Compound armor.
Conning tower.
Cut-splice.
Cutting punch.
Cyclad.
Davit.
Deck hook
Deck light.
Deck plate.
Deck pipe.
Deck stopper.
Devil's claw.
Diamond knot.
Diving apparatus.
Diving bell.
Diving dress.
Dog shank.
Dog stopper.
Double knot.
Double purchase.
Double-rail stanchion.
Double whip
Drawing splice.
Dredge.
Dredging machine.
Drilling scow.
Ducking boat.
English knot.
Eyelet grommet.
Eyelet hole.
Eye seizing.
Eye splice.
Fake.
Faking box.
Ferry boat.
Fid-hole.
Figure-of-8 knot.
Flemish knot.
Floating dock.
Flush-deck windlass.
Fog alarm.
Fog bell.
Fog horn.
Fog signal.
Fog trumpet.
Fog whistle.
Folding boat.
Forelock.
Four-stranded splice.
Gaff-topsail hook.
Galley knot.
Gasket.
Gin block.
Gorge.
Goring cloth.
Grafting.
Grapnel.
Grommet.
Gun-tackle purchase.
Gunwale.
Half hitch.
Hammock clew.
Hammock cloth.
Hanging block.
Harbor gasket.
Harness hitch.
Hawser.
Hawser bend.
Hawsing beetle.
Hawsing iron.
Head earrings.
Heaver.
Hitch: —
  Clove hitch.
  Half hitch.
  Harness hitch.
  Marlinspike hitch.
  Midshipman's hitch.
Hook: —
  Bench hook.
  Block hook.
  Gaff-topsail hook.
  Match hook.
  Self-mousing hook.
  Sister hooks.
Horse hammock.
Hydraulic steering gear.
Ice boat.
Ice yacht.
Illuminator.
Iron clad.
Iron strapped block.
Jib hank.
Jib head.
Jumper stay.
Kedge.
Kedging.
Knot: —
  Artificer's knot.
  Boat knot.
  Bowline knot.
  Bowline on a bight.
  Builder's knot.
  Capstan knot.
  Carrick bend.
  Clove hitch.
  Diamond knot.
  Dog shank.
  Double knot.
  English knot.
  Figure-of-8 knot.
  Flemish knot.
  Galley knot.
  Half-hitch.
  Harness-hitch.
  Hawser bend.
  Hitch.
  Lark's head.
  Lashing knot.
  Loop knot.
  Marlinspike hitch.
  Matthew Walker knot.
  Midshipman's hitch.
  Overhand knot.
  Prolonge knot.
  Reef knot.
  Rosette.
  Sheep shanks.
  Shortening knot.
  Shroud knot.
  Six-fold knot.
  Sprit-sail-sheet knot.
  Taek knot.
  Twist knot.
  Wall and crown.
  Wall knot.
  Weaver's knot.
Kyak.
Lacing.
Lanyard.
Lark's head.
Lashing.
Lashing eye.
Lashing knot.
Launch.
Launch engine.
Lazy painter.
Life boat.
Life buoy.
Life preserver.
Life raft.
Life-saving apparatus.
Life-saving suit.
Lift jigger.
Lizard.
Lobster claw.
Long rolling splice.
Long splice.
Loop knot.
Lubber's mark.
Luff tackle.
Luff tackle purchase.
Luminous buoy.
Main keel.
Marine drag.
Marine governor.
Marine signal.
Marlinspike.
Marlinspike hitch.
Mast.
Mast-head.
Mast-head pendant.
Mast hinge.
Mast lining.
Mat.
Match hooks.
Matthew Walker knot.
Midshipman's hitch.
Mooring swivel.
Mousing hook.
Nautigon.
Nautilus.
Nettle stuff.
Nippers.
Oar.
Outrigger hoist.
Overhand knot.
Painter.
Palm.
Parceling.
Passing nippers.
Pawl.
Paunch mat.
Pendant tackle.
Pin.
Pinkie.
Point.
Ponton.
Popofka.
Poppets.
Portable boat.
Portable raft.
Port hinge.
Post.
Pressure log.
Preventer fid.
Preventer stay.
Pricker.
Prolonge knot.
Propeller.
Propeller coupling.
Propeller mechanism.
Propeller shaft.
Puddening.
Pudding splice.
Purlin.
Quarter.
Quarter tackle.
Racking.
Racking turns.
Raft.
Reef earrings.
Reefing apparatus.
Reef knot.
Reef-tackle purchase.
Reeving line.
Reliever.
Relieving tackle.
Reversing gear.
Rigger screw.
Rigging stopper.
Ring splice.
Roband.
Rosette.
Rose lashing.
Round scuttle.
Round seizing.
Rowing gear.
Rowlock.
Rudder.
Rudder brace.
Rudder gudgeon.
Rudder screw.
Sailing car.
Score.
Screw propeller.
Screw steering apparatus.
Scuttle.
Self-mousing hook.
Seizing (varieties, see list): —
  Cross seizing.
  End seizing.
  Eye seizing.
  Flat seizing.
  Gasket.
  Harbor gasket.
  Fox.
  Lacing.
  Laniard.
  Lashing.
  Lashing eye.
  Mat.
  Nettle stuff.
  Parceling.
  Puddening.
  Puss.
  Quarter seizing.
  Racking.
  Roband.
  Rose-lashing.
  Round seizing.
  Sennit.
  Serving.
  Spanish fox.
  Splice.
  Throat seizing.
  Whipping.
  Worming.
Sennit.
Serving.
Setting die.
Shackle.
Shaft.
Sheath.
Sheave.
Sheave-hole.
Sheepshanks.
Sheet anchor.
Sheet slip.
Sheet traveler.
Shelf piece.
Shell.
Ship.
Ship ring-bolt.
Ship scraper.
Ship's spike.
Shore.
Shortening knot.
Short splice.
Short stay.
Shroud knot.
Side scuttle.
Single whip.
Sister block.
Sister hooks.
Six-fold knot.
Skiff.
Sky-light guard.
Sky-light lift.
Slings.
Slip stopper.
Snatch block.
Sneak box.
Sound house.
Sounding.
Sounding apparatus.
Spanish fox.
Spanker gaff.
Spare anchor.
Spider hoop.
Splice: —
  Caut splice.
  Cut splice.

Splice:—
Drawing splice.
Eye splice.
Four-stranded splice.
Grafting.
Long rolling splice.
Long splice.
Pudding splice.
Short splice.
Tapered splice.
Sprit-sail gaff.
Sprit-sail sheet knot.
Stanchion.
Steamboat.
Steamer.
Steam ferry.
Steam tug.
Steering apparatus.
Step.
Stern benches.
Stern sheets.
Stern walk.
Stopper.
Storm valve.
Strap.
Strap-bound block.
Stream anchor.
Stretcher.
Stud.
Submarine armor.
Surf boat.
Swallow.
Swimming apparatus.
Swivel.
Swivel block.
Sword mat.
Tack knot.
Tackle:—
Block.
Boom tackle.
Bouche.
Bowline tackle.
Brace block.
Bushing.
Channel.
Cheek.
Coak.
Double purchase.
Double whip.
Gin block.
Gorge.
Gun-tackle purchase.
Hanging block.
Iron-strapped block.
Lift jigger.
Luff tackle.
Luff-tackle purchase.
Mast-head pendant.
Pendant tackle.
Pin.
Quarter tackle.
Reef-tackle purchas
Relieving tackle.
Score.
Sheave.
Shell.
Single whip.
Sister block.
Snatch block.
Strap.
Strap-bound block.
Swallow.
Swivel block.
Tail jigger.
Threefold purchase.
Top burton.
Top-burton tackle.
Top tackle.
Treble purchase.
Truss tackle.
Two-fold purchase.
Whip-on-runner.
Yard tackle.
Tail jigger.
Tapered splice.
Thimble.
Three-fold purchase.
Throat seizing.
Thrum mat.
Thrust bearing.
Thwarts.
Tiller.
Top burton.
Top-burton tackle.
Top lining.
Top maul.
Top rim.
Top tackle.
Towing.
Treble purchase.
Trip hook.
Truss tackle.
Try-sail gaff.
Turnbuckle.
Twice-laid.
Twin boat.
Twin steamer.
Twist knot.
Two-fold purchase.
Upper deck.
Wall and crown.
Wall knot.
Warping.
Water ballast.
Water-deck iron.
Weaver's knot.
Wedge.
Well sneak.
Whip-on-runner.
Whipping.
Whisker gaff.
Wing stopper.
Wire-rope towage.
Withe.
Worming.
Yacht.
Yard-arm.
Yard-tackle purchase.
Yarn.
Yawl.

Nau'ti-cal Alarm. See under various heads: BUOY; FOG TRUMPET; SIRENE, etc. See also MARINE ALARM.

Nau'ti-gon. An instrument invented by Dr. Hill, of Harvard, for solving by inspection, without the use of tables, any problem in spherical trigonometry, with sufficient accuracy for the principal problems of practical navigation.

"*Scientific American*" . . . . . xxxvi. 85.
* "*Scientific American Supplement*" . . . 314.

Nau'ti-lus. A name for the diving bell. See cap. "*Plongeur*," *Laboulaye's* "*Dictionnaire des Arts*, etc.," Figs. 3686, 3687.

Nav-i-ga'tion-al Sound'ing Ma-chine'. A machine for taking soundings *en route*. The invention of Sir William Thomson. See FLYING SOUNDER.

Nav'i-sphere. A nautical instrument, by M. de Magnac. It is designed to indicate, without calculation, the names of the stars above the horizon at a given moment (with altitude and azimuth), the angle of route for going from one point to another by the arc of a great circle, and the approximate distance between these points. Spherical triangles may also be solved with it. For a detailed description see the "*Comptes Rendus*" of the Academy; and for an abstract, London "*Nature*."

Nav'vy. A species of excavator, which see.

Steam navvy . . "*Scientific American*," xxxvi. 399.

Neb'u-li-zer. (*Surgical.*) A spray instrument. See ATOMIZER.

Ne-ces'saire. (*Optics.*) A circular base of polished wood, in which 6 re-agent bottles are arranged with ground capillary tube stoppers, and the whole covered with a low bell-glass to exclude dust.

Ne-cro'sis For'ceps. (*Surgical.*) An instrument for gnawing away portions of diseased bone. They are of various shapes: front cutting, side-cutting, curved on the flat, serrated, knee-curve, gouge-shaped, etc. See list under FORCEPS.

Nee'dle. The process of needle-making in 35 operations is described under cap. "*Aiguilles*," *Laboulaye's* "*Dict. des Arts et Sciences*," i., ed. 1877.

The following is the series of operations in the works of the *National Needle Co.*, Springfield, Mass.:—

Blank.
Reduced blank.
Reduced and pointed, blank.
Grooved.
Eye-punched.
Hardened and tempered.
Hard-bur dressed.
Brass brushed.
Eye-polished.
First inspection.
Hard straightened.
Finish-pointed.
Finished.

See *Dr. Knight's* Report on "*Sewing Machine Needle Machinery*," at the National Needle Co.'s works, Springfield, Mass., "*Centennial Exhibition Reports*," vol. vii., Group XXII., p. 59, *et seq.*

Open-eyed needles for threading without reeving; numerous instances, Fig. 3305, p. 1517, "*Mech. Dict.*"

(*Surgical.*) The uses of the needle in surgery, for operation and suture are numerous. The names signify the material, construction, or application. Among them are the following, the greater number of which may be found under their alphabetical heads in this or former volumes:—

Acupuncture.
Aneurism.
Angular.
Artery.
Canulated.
Cataract.
Couching.
Discission.
Eye.
Fistula.
Harelip.
Helical.
Hernia
Hypodermic syringe.
Iris.
Ligature.
Milium.
Nævus.
Open eyed
Paracentesis cornea.
Perineal.
Seton.
Staphylorraphy.
Stop.
Suture.
Tattooing.

See also ACUS, *supra*; also NEEDLE. 2. SURGICAL, p. 1517, "*Mech. Dict.*," NEEDLE FORCEPS, Fig. 3306, p. 1518, *Ibid.*

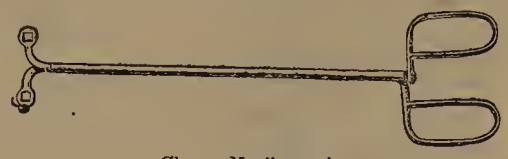
See: Clamp for sewing machines, *Morton* . * "*Scientific Amer.*," xxxvii. 182.
Sewing machine needle making . . . . . * "*Scientific American Sup.*," 544.
Machinery . . . . . * "*Scientific Amer.*," xxxvii. 130.
Cap. "*Aiguilles*" . . * *Laboulaye*, i., ed. 1877.
Making . . . . . * "*Scientific American Sup.*," 856.
"*Scientific American*," xxxv. 403.

Nee'dle An-nun'ci-a'tor. 1. A form of optical telegraph in which a finger moving on a dial indicates a letter or a message. See DIAL TELEGRAPH, Fig. 806, p. 254, *supra*. Fig. 6238, p. 2506, "*Mech. Dict.*," Fig. 1667, p. 708, *Ibid.*

2. A form of annunciator in which several messages, numbers of rooms, or office departments may be placed on a board and a needle caused to point to either, at the option of the sender.

Nee'dle Car'ri-er. A *porte-aiguille*. A needle forceps. In the instance given, Dr. Turnipseed's clamp needle-carrier for operation in vesico-vaginal fistula, the needles clamped in the ends of the arms have a mutually approaching transverse

Fig. 1806.



Clamp Needle-carrier.

motion as the loops of the handle are partially rotated by pressing together.

Nee'dle For'ceps. An instrument to hold a needle in sewing up wounds.

In the instance, Fig. 1807, *Dr. Thornton Parker's*, the threaded needle is held by a screw clamp, and may have any

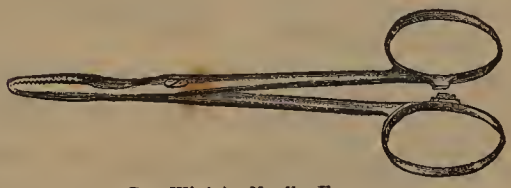
Fig. 1807.

Dr. Parker's Needle Holder.

convenient angle of presentation. The hollow handle holds needles.

Dr. Wight's needle forceps has serrated jaws, and a catch

Fig. 1808.

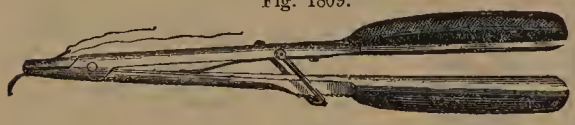


Dr. Wight's Needle Forceps.

on each bow to lock the forceps shut. Used also in removing pieces of necrosed bone, in arresting arterial hemorrhage, etc.

Fig. 1809 shows the needle forceps of *Dr. Anatole de Gaine*,

Fig. 1809.

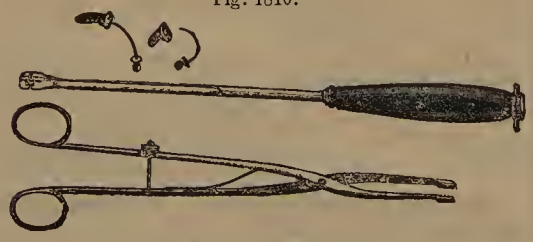


Dr. De Gaine's Needle Forceps.

of St. Petersburg. The needle is held at any angle, and the handles are locked by link and ratchet.

Dr. Turnipseed's needle holder, needles, and clamps, for uterine operations, are shown in Fig. 1810. The needles pro-

Fig. 1810.



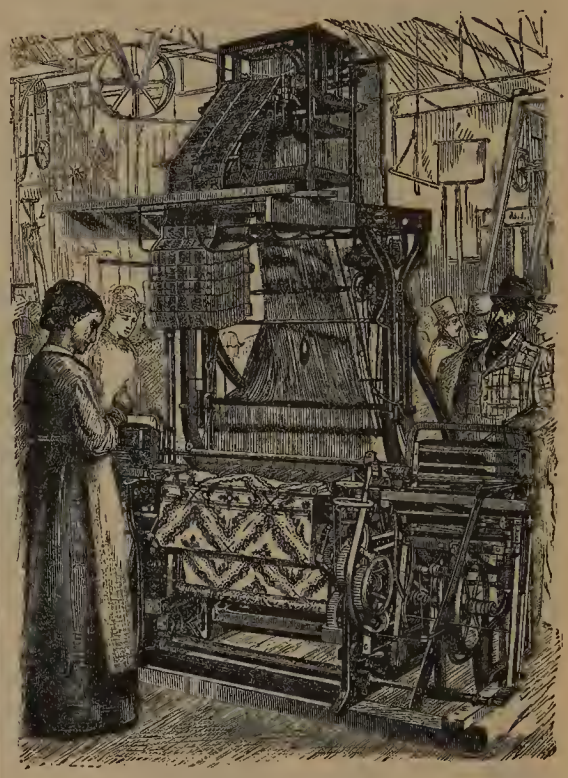
Dr. Turnipseed's Needle Forceps.

jecting transversely to the line of the handle, are thrust through the lips of the wound by a partial rotation of the handle, and the ends of the needles received in clamps, which are pressed down upon the needle, preventing retraction. The clamp closer is shown below.

Nee'dle Loom. A loom in which the weft is thrust through the shed by a rod, known as a *needle*. Fig. 1811 shows a four-harness Jacquard loom of Dienelt & Eisenhardt, for weaving ingrain carpets. It has a capacity for 16 weft threads of varying colors.

The pattern mechanism acts upon separate lifters, through which the 8 colored threads of the weft respectively pass. The colored yarn which is required for the next throw is

Fig. 1811.



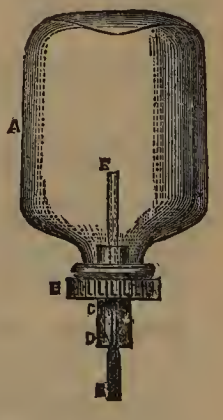
Ingrain Carpet Needle Loom.

elevated so as to be caught in the slot of the reciprocating needle and carried half way through the shed, where it is caught by a hook which has advanced from the other selvage to meet it, and the loop is drawn back to the selvage by the hook, laying two threads in the shed. The loop of the weft is then caught by a latch-needle, which is moved in a direction across the path of the weft and is knit in with the former loop.

See also CARPET LOOM, p. 169, *supra*.

Nee'dle Lu'bri-ca'tor. A form of lubricator consisting of a strong globe of glass having a neck or outlet fitted with a stopper of wood, through which is a conical metal tube, forming the only exit for the oil. In order to regulate the supply of oil, a metallic feed-rod (needle) passes through the tube, and rests upon the shaft to be lubricated.

Fig. 1812.



Needle Lubricator.

Neg'a-tive. 1. (*Electricity.*) In the battery, the copper, carbon, or platinum plate.

See list in Negative columns, tables of Galvanic Batteries, pp. 367–373 *supra*.

2. (*Photography.*) The cliché or picture in reverse; from it the *positive* is printed.

Neg'a-tive Rack. A frame for holding glass negatives to drip. See Fig. 1813.

Nerve In'stru-ments. (*Dentistry.*) Instruments for broaching, cleaning, filling, etc., the nerve cavity. Fig. 1814.

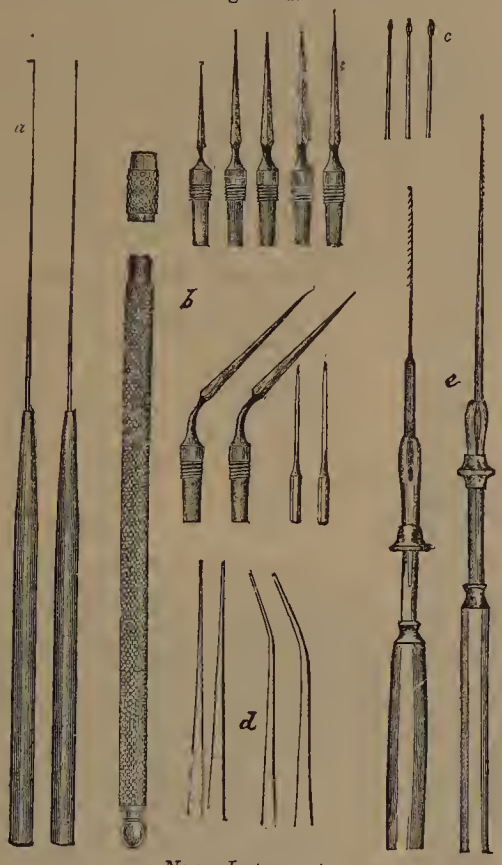
a. Spring tempered *nerve bristles*, for removing pulp, cleansing pulp-canals, introducing medicaments in the treatment

Fig. 1813.

Folding Negative Rack.

of alveolar abscess, etc. Some are roughened, some have minute hooks at the end. There are 10 in a set.

Fig. 1814.



Nerve Instruments.

b. Nerve-canal reamers, for cleansing and preparing nerve canals. A set consists of 14 triangular and 3 4-sided reamers.
c. Bur drills, used in drilling fangs preliminary to filling.
d. Nerve-cavity pluggers.
e. Nerve extractors. Barbed bristles.

Neurotome; excision of dental nerve * "*Sc. Am. Sup.*," 4114.

Nest Spring. A spiral spring of several concentric coils. *s. t.*, Fig. 1143, p. 483, "*Mech. Dict.*"

Net. For list of U. S. Patents, fishing nets, pounds, traps, seines, eel pots, etc., see FISHING NET, p. 342, *supra.*

See also: —

Anchored net.
Bag.
Bag net.
Bait net.
Bar net.
Bar weir.
Bowl.
Bull net.
Casting net.
Cast net.
Collecting seine.
Crab net.
Crib.
Dip net.
Dipping wheel.
Dredge.
Drift net.
Drop net.
Eel pot.
Float.
Folding net.
Fyke net.
Gill net.
Handle net.
Haul seine.
Heart.
Heart net.
Heart seine.
Hook.
Hook net.
Jerk net.
Landing net.
Leader.
Line.
Lint.
Meshing net.
Meter.
Pocket net.
Pot.
Pound.
Pound net.
Purse net.
Purse seine.
Scoop net.
Seaming.
Seine.
Seine windlass.
Sheave block.
Skim net.
Stake net.
Tilting net.
Towing net.
Trailing net.
Trammel net.
Trap.
Trap net.
Trawl net.
Tunnel.
Weir.
Wing.
Wing net.

Also: —

Garden net, over fruit trees.
Fly net.
Horse net.
Poultry netting, to limit their range. A sort of fence.
Spring net; one closed by trigger and spring; used in catching rabbits.
Banner netting, for painting signs or banners, to be suspended across a street, and avoid carrying away by the wind.
Clap net; one having hinged sections; used in bird-catching.
Hammock net; open-work netted hammock.
Vat net, for a strainer.
Quail or partridge net, for catching those birds.
Lawn-tennis net; used in the game.

Net'ma-ker's Knife. (*Fishing.*) A blade (2″) without a handle, and the heel of the blade curved so as to fit the finger like a ring.

Net'tle. (*Nautical.*) A small cord used for seizing or grafting, as the *nettles* (*knittles*) of a hammock.

Net'tle Stuff. (*Nautical.*) Small line used for seizings, worming, etc.

New Pro'cess Mil'ling. See CYLINDER MILL; ROLLER MILL; HIGH MILLING; MIDDLINGS PURIFIER, etc., and "*American Miller*," vi. 2.

Ni-au'det Bat'te-ry. (*Electricity.*) Otherwise known as the *chloride of lime battery.* The positive electrode is a plate of zinc in a solution of chloride of sodium; the negative element is a plate of coke surrounded by coke fragments and chloride of lime in a vessel of biscuit ware or parchment paper.

Nic'ol's Prism. (*Optics.*) A prism of Iceland spar so constructed as to transmit but one of the two rays into which light is divided in passing through this substance — polarizing the same.

Used in connection with the polariscope for the microscope. See POLARISCOPE.

Nick'el. See data on p. 1525, "*Mech. Dict.*"

The alloys of nickel are of considerable importance. It unites readily with iron, cobalt, copper, antimony, zinc, tin, etc.

The alloys of nickel with copper and zinc form German silver or albata (Eng.), *Argentan* (Fr.) *Packfong* (Ch.). See list, p. 63, "*Mech. Dict.*"

Britannia metal is principally copper, tin, and antimony. French recipes: —

	Copper.	Nickel.	Zinc.
1. Common *argentan* . . .	16	4	7
2. White *argentan*	16	6	7
3. Electrum	16	8	7
4. Electrum	16	12	7
5. Tutenag	16	6	11

Solder for *argentan*; argentan (No. 1), 5 parts; zinc 4 parts.

Nickel	"*Scientific A nerican*," xxxv. 149.
And cobalt at Centennial.	
Wharton	"*Eng. & Min. Jour.*," xxiii. 13.
Battery, *Slater* . . .	* "*Scientific American Sup.*," 3341.
Bronzc	"*Manuf. & Builder*," xii. 197.
Furnaces	"*Eng. & Min. Jour.*," xxv. 326, 346, 424 : * xxvi. 24.
Plating, *Stolba* . . .	"*Sc. American*," xxxvi. 295.
Plating, *Wharton* . .	"*Iron Age*," xxv., April 8, p 9.
Litigation	"*Iron Age*," xxv., April 29, p. 9.

At Krageroe, Norway, magnetic pyrites, holding on an average 1.25 per cent. of nickel, are worked by the following process: "The raw ore is smelted with slag from refining in a 13-foot 3-tuyere shaft furnace, the slag made being thrown over the dump while the raw matte, holding 3.5 per cent. of nickel, is roasted in stalls. This roasted matte is smelted in a low furnace with one tuyere, 4′ high. The slag, holding 1 to 1.5 per cent. of cobalt, goes to the ore smelting. The matte made contains 30 per cent. of nickel and 15 per cent. of copper, and is returned to the same furnace, which concentrates it to 60 per cent of nickel and 30 per cent. of copper. The sulphur is only 10 per cent. This matte is ground and roasted completely in a small reverberatory furnace, and the oxides are reduced with charcoal powder in graphite crucibles, yielding 68 per cent. of nickel and 30 per cent. of copper. By the addition of copper this product is smelted into an alloy of one of copper and one of nickel, which is marketable."— *Friedr. Bode in "Dingler's Polytechnic Journal."*

In Plazanet's nickel-plating process a bath is used of 87.5 grams of sulphate of nickel, 20 sulphate of ammonia, 17.5 citric acid, and two liters of water. A bath much used in France is formed of a solution of 4 parts of nitrate of nickel in 4 of liquid ammonia, and 150 water, in which 50 parts of sulphate of soda have been dissolved. Using a moderately weak current, the operation is at an end in a few minutes. There is no need to interrupt it by taking the objects out and brushing them. When the film of nickel is of sufficient thickness, the objects are withdrawn from the bath and dried with sawdust.

A new nickel-plating solution, said to yield beautiful results, is prepared by mixing the liquid obtained by evaporating a solution of ½ oz. nickel in aqua regia to a pasty mass and dissolving it in 1 lb. aqua ammonia, with that obtained by treating the same quantity of nickel with a solution of 2 ozs. cyanide of potassium in 1 lb. of water. More cyanide renders the deposit whiter, and more ammonia renders it grayer.

Nick'el Bat'te-ry. (*Electricity.*) *Slater.* One form consists of a vessel with two interior porous concentric cells. In the central one is placed the plate of nickel with its excitant, dilute sulphuric or other acid; in the middle space is a solution of sesqui-carbonate of ammonia; in the outer space is a solution of sulphate of nickel, or the double sulphate of nickel and ammonia, together with suspended prisms or plates of carbon. The deposited salts are of commercial value.

Slater . .	"*Scientific American Supplement*," * 3341, 3790.
Wenzel .	"*Scientific American*," * xxxix. 150.

Nick'el Bronze. An alloy named from M. Jules Garnier, the inventor. The *garnierite*, an ore of nickel found in great quantity in New Caledonia, is worked in Nouméa, and the regulus shipped to Septemes, near Marseilles.

Here the pure metal is mixed with various proportions of copper, zinc, and tin, forming nickel bronze. Twenty per cent. of nickel suffices to give the desired tint, and to secure inoxidizability. All articles now made of brass or copper, nickel plated, can be produced in solid bronze by the same processes and with the same plant, and at practically the same cost. So made they are 20 per cent. stronger, and may generally be much lighter. Its great strength and the property of non-oxidization make this alloy eminently suitable for mathematical and musical instruments. It is used for:

Builders' fittings.	Harness trimmings.
Chains.	Arms.
Scientific instruments.	Clocks.
Art-metal work.	Bells.
Journal bearings.	Propeller journals.

See: "*Iron Age*"	xxiii., Jan. 16, p. 13; xxiv., Nov. 27, p. 13; xxv., May 20, p. 19.
"*Eng. and Min. Journ.*" . .	xxv. 26; xxvii. 76; xxix. 389.
"*Am. Manuf. and Iron World*"	xxvi., May 28, p. 7.
"*Scientific American*" . . .	xlii. 288.
"*Manufact. and Builder*" . .	xii. 144, 197.
Guillemin "*Technologiste*," .	xl. 364.

Nick'el-ine. The term given by Guillemin to nickel bronze. "*Technologiste*," xl. 364.

Nick'el Plat'ing. Nickel galvanoplasty for electrotypes and reproductions of works of art, has been much advanced by Boudreaux (*père et fils*), of Paris. The great difficulty attending the deposit in any considerable thickness, is owing to the tendency to exfoliate and curl, which is ascertained to be due to the absorption of hydrogen.

"This mode of accounting for the phenomenon will be readily accepted, if it be borne in mind that in this case the nickel crystallizes; that it is very porous as compared with ordinary cast nickel; and that in 12 hours it condenses 160 times its own weight of hydrogen, when it is attached to the negative pole of a rather powerful galvanic battery, in the electrolysis of water."— "*Electrician*," Feb., 1882, p. 24.

The advantage of nickel for type plates and art reproductions is evident from the fact that with about the same density (Cu., 8.90; Ni., 8.57) the resistance of nickel to mechanical pressure is about 3 times that of copper. Nickel is also much less affected by colored inks.

Prof. Stolba's Process: To a dilute solution of chloride of zinc (5 to 10 per cent.) enough nickel sulphate is to be added to impart a decidedly green color to it, and the solution is then to be heated to boiling in a porcelain vessel. The clouding of the liquid from a separation of a basic zinc salt need not be heeded, as it will not interfere with the effectiveness of the bath. The articles to be nickel-coated — first carefully cleaned of oxide or grease — are to be suspended in the solution from 30 to 60 minutes, the bath being kept at a boiling temperature. When articles are observed to be uniformly coated, they may be removed, washed in water in which a little chalk is suspended, dried and finally polished with chalk or other suitable material. By the substitution of a cobalt salt in place of the nickel, objects may be similarly coated with cobalt.

U. S. Patents since list pp. 1525, 1526, "*Mech. Dict.*": —

121,383	. . . .	*Keith*	1871
125,868	. . . .	*Whitman & Neal* . . .	1872
128,166	. . . .	*Parmalee*	1872
129,881	. . . .	*Beardslee*	1872
130,362	. . . .	*de Lobstein*	1872
136,634	. . . .	*Adams*	1872
154,435	. . . .	*Adams*	Aug. 25, 1874
155,884	. . . .	*Normandeau*	1874
6,313	(Reissue)	*Adams*	Mar. 2, 1875
6,402	(Reissue)	*Adams*	Ap. 27, 1875
172,862	. . . .	*Adams*	Feb. 1, 1876
228,390	. . . .	*Pomeroy* . . .	June 1, 1880
228,921	. . . .	*Perry*	June 15, 1880

See also "*Elements d'Électro Chimic*," Paris, 1864, p. 325.

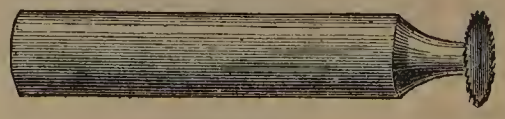
(*Glass.*) Recommended by M. Clémendot, a French glass manufacturer, to nickel-plate all pontys and molds for glass-making, to prevent coloration of the glass by oxidation of the iron tools. Steep the objects for a few hours in a plating bath of sulphate of nickel and ammonia.

Lockert, on	"*Technologiste*," xli. 392.
Stolba	"*Technologiste*," xxxviii. 66.
Kayser	"*Technologiste*," xl. 89.
	"*Scientific Amer.*," xxxvi. 408; xxxviii. 209.
Stolba	"*Scientific Amer.*," xxxvi. 295.
Wharton	"*Iron Age*," xxv., April 8, p. 9.
Litigation	*Ibid.*, xxv., April 29, p. 9.

Nick'el Steel. An alloy of cemented iron and nickel. — *Boussingault.*

Nick'ing Saw. A small circular saw, used in nicking screw-heads, etc.

Fig. 1815.



Nicking Saw.

Ni-el'lo. (*Fine Art Metal-working.*) Formerly, a metallic plate was engraved and the lines run full of an alloy which became black by heat. The surface being scraped down, the effect was of a drawing in black on the gold or silver plate.

On a larger scale, brass monumental plates were similarly ornamented, and the alloy formerly used, which was of copper, silver, lead, etc., was substituted by enamel, and then by black wax.

The latter style lives in the shop and door-plates of our streets.

Artistic work is yet produced in this line, black enamel and red copper being used, the latter deposited in the electro-bath.

See also p. 1526, "*Mech. Dict.*"

One beautiful form of niello is a sort of enameling upon silver; with a paste consisting chiefly of the sulphide of the metal itself. The process is as follows: —

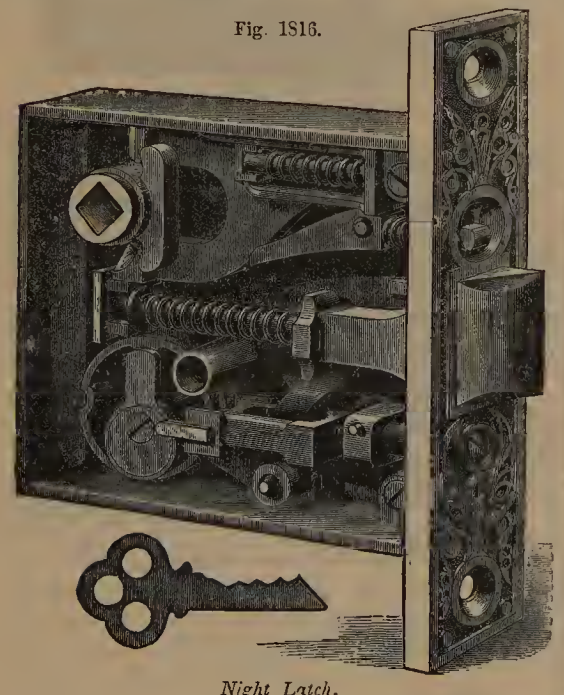
Take 4 drachms of silver, 2 oz. and 4 drachms each of copper and sal-ammoniac, 3 oz. and 4 drachms of lead, and 12 oz. of flowers of sulphur. Make a paste of the flowers of sulphur and water; put it into a crucible; afterwards melt the metals, and pour them into the crucible which contains the paste; re-cover this vessel in order that the sulphur may not take fire, then calcine over the fire until all the superfluous sulphur is driven off; afterwards finely pulverize the mass, and make, with the addition of a solution of sal-ammoniac, a paste, which introduce by means of rubbing, into the parts intended to be enameled; then clean the article, and place it in a furnace, where it is sufficiently heated to melt the paste which fills the engraved parts and makes it adhere to the metal. That done, moisten the article with a solution of sal-ammoniac, and heat it in a muffle to redness; after which you may rub and polish the article when it has become cold without fear either of altering or of detaching the enamel; it remains always of a very fine black color. — *Dr. Percy.*

Ni-el'lo Sil'ver. The composition of the Russian tula, or Niello silver, long kept secret, has been announced to be as follows: —

It consists of 9 parts silver, 1 part copper, 1 part lead, and 1 part bismuth, which are melted together and saturated with sulphur. This mixture produces the gorgeous blue which has often been erroneously spoken of as steel blue. — "*Berliner Tagblatt.*"

Night Latch. A lock operatable by key only from the outside, by handle from the inside; but capable of being fastened by a catch so that the bolt becomes immovable.

Fig. 1816.



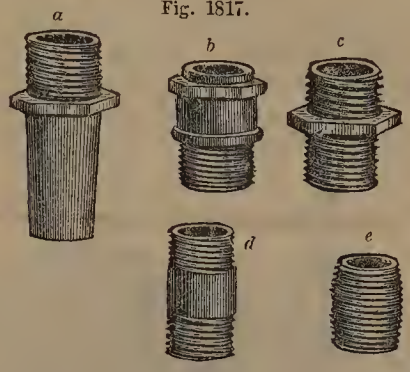
Night Latch.

The illustration shows a mortise lock, adjustable to right or left-hand doors.

Nip'pers. (*Nautical.*) An elastic hank made of strong yarns, laid parallel and marled from end to end. It is used for binding the messenger to the cable.

Nip'ple. A pipe coupling of reduced size, frequently threaded on the outside to allow the wire binding to compress the attached hose into the depressions of the thread.

Fig. 1817.



Nipples.

a. One end screw, the other solder.
b. Screw, and screw socket ends respectively.
c. Double screw.
d. Shoulder.
e. Close.

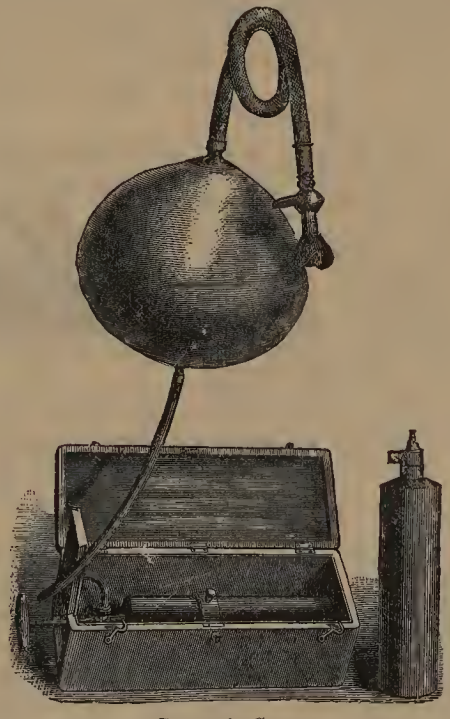
Ni'tro-gel'a-tine. An explosive agent invented by Nobel; formed by dissolving gun-cotton in nitroglycerine, with camphor added in varying proportions, nominally 4 per cent. See BLASTING GELATINE, p. 105, *supra.*

Ni'tro-gly'cer-ine. The subject is discussed and numerous references given on pp. 1529, 1530, "*Mech. Dict.*"

See also "*Scientific American,*" xxxiv. 341; xxxviii. 58; "*Scientific American Supplement,*" 3874.

Ni'trous Ox'ide Ap'pa-ra'tus. This comprises a strong cylinder containing 100 gallons of gas compressed to a pressure of 80 lbs. to the square inch at 60° Fah. The case is provided with an iron ring and set screw, by which the iron cylinder is held in place during use, and its valve protected from injury; also, a rubber bag with rubber

Fig. 1818.



Surgeon's Case.

tube at one end for admission of gas; and a tube, terminating in an inhaler, at its opposite end.

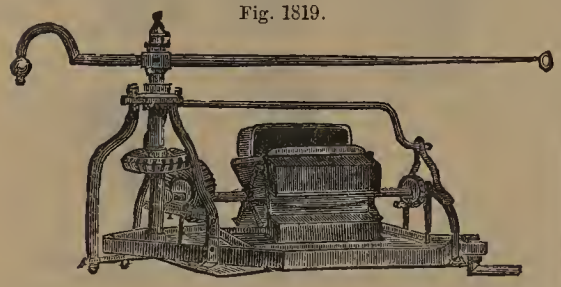
See also Figs. 3331, 3332, p. 1530, "*Mech. Dict.*"
Nitrogen gas apparatus, *Blair,* * "*Sc. American,*" xxxix. 21.

Non'-con-duct'or. (*Electricity.*) Anything that does not freely transmit the electrical current, such as glass, hard rubber, dry wood, etc.

No'ri-a. (Arabic, *Na' Ura.*) A water-raising device consisting of a chain of pots or buckets. A very ancient device, still very crude in Syria and Egypt. See Figs., p. 1533, *"Mech. Dict."*

Fig. 1819 shows a modern French form in which the main features of the ancient contrivance are preserved, but with

Fig. 1819.



Modern Noria.

the aid of improved construction and materials. The animal, an ox usually, travels in the accustomed route; the interposition of a single pair of gears transposes the motion from the vertical to the horizontal, and upon the shaft are iron chains and buckets, the substitutes for the ropes and pots.

Nose Com'press. Pinchers for the nose, when administering gas from a *mouth*-piece, and not from a face-piece.

Fig. 1820.

Nose Compress.

Nose Glass. (*Optics.*) A *pince-nez*, or folding eye-glass, supported by grasping the nose instead of the temples.

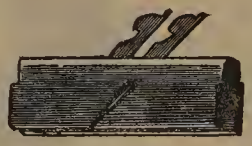
No'sing. The keeper of a lock, into which the latch or bolt engages.

No'sing Mo'tion. Refers to appliances for the perfect winding of yarn on the noses of the spindles, by an accelerating motion, to secure tightness of the yarn on the reduced diameter of the upper end of the mule spindle.

See article by Mr. Eli Spencer, of Oldham, in *"Engineering,"* xxx. 510, Figs. 8 to 12.

No'sing Plane. A plane with hollow-rounded sole, for dressing the front edges of wooden treads of stairs.

Fig. 1821.



Nosing Plane.

Notch'ing Ma-chine'. 1. (*Sheet-metal Working.*) A machine for cutting the corners and notches for square boxes, hinges, etc. It has adjustable gages, works with a foot-treadle, and will cut several thicknesses at once: 12,000 notches in 10 hours.

2. A machine for cutting notches in blanks for paper boxes or envelopes. See Fig. 693, p. 222, *supra.*

Noz'zle. A discharge-pipe or ventage.

The nozzles of the placer mines in California are shown in Fig. 2616, p. 1149, *"Mech. Dict.,"* and the subject also considered under HYDRAULICKING, p. 481, *supra.*

With the introduction of iron pipe, the nozzles were gradually enlarged, and the "Little Giant," a large cast-iron nozzle working on a swivel joint, was introduced.

Craig discovered that by rifling the Little Giant, the jet, instead of whirling and expanding, shot out straight, retaining its full force. Then Hoskins invented the second joint to the "Little Giant," which enables the raising or lowering of the nozzle, and under several inventions a nozzle has been perfected, the largest of which can be moved in any direction by a child; one of eight inches, with 200 feet head, capable of moving 3,000 cubic yards per day, being operated by one hand with ease. Thus one man, with perfect ease moves as much gravel in a day as 1,000 men could with shovels and cars.

Controlling nozzle, *Clemens*, * Fig. 685, p. 219, *supra.*

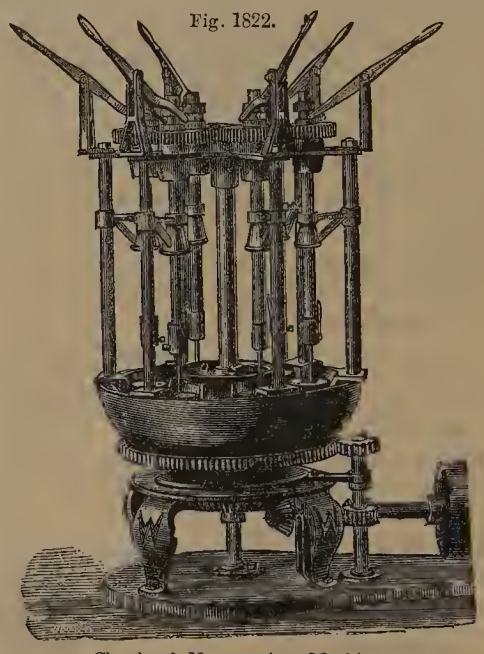
Nut Lock. A device to keep a nut from turning on the bolt. See Fig. 3350, p. 1538, where 46 illustrations are given.

* *"Scientific Amer.,"* xxxviii. 244
Conical, *Atwood* . . . * *"Railroad Gazette,"* viii. 34.
Grubb . . . . . * *"Scientific American,"* xli. 86.
Fish-plates, *Skinner*, Br. * *"Engineer,"* xlvi. 146.
Atwood . . . . . * *"Scientific American,"* xliii. 386.
Whitmarsh . . . . * *"Scientific American,"* xxxix. 230.

Nut-tap'ping Ma-chine'. A machine for cutting threads in punched nut blanks.

The machine shown in Fig. 1822 consists of a solid cast-iron platform, upon which rests a bowl which is kept nearly full of water; on the top of this bowl is a solid six-armed plate upon which rest six nut chucks; above this plate there

Fig. 1822.



Cleveland Nut-tapping Machine.

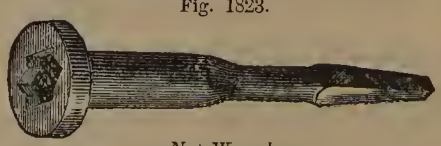
is a top plate supported by iron columns, in the center of which there is a vertical driving shaft, on the head of which there is a cog-wheel. Around this cog-wheel at regular distances apart are six spindles. The tap goes in at the lower end of the spindle, each spindle being over a nut-chuck on the bottom plate. The top and bottom plates being securely bolted together, have a rotary motion, and at the same time the gearing is so constructed that the six vertical spindles, being propelled by cog gear at the top, perform the work of tapping nuts as they pass around. One person can manage the machine. The water in the bowl comes up to the surface of the nut chuck or seat, and about a quarter inch of oil floats upon the water, coming over the nut (one quart of oil being sufficient for the tapping of a ton of nuts).

Each tap will hold from 8 to 12 nuts, which, fast as they are cut, rise to give place to the next one. When the tap is full, the attendant releases it, removes the nuts, and replaces the tap, which is ready to operate as before.

See: Cold punching . . * *"Iron Age,"* xxii., Aug. 15, p. 1.
Forg. mach., *Horsfall* . * *"Scientific American Sup.,"* 1491.
Horsfall, Br. . . . * *"Engineer,"* xliv. 148.
Boring, tapping, facing, & slotting, *Hartnell*, Br.* *"Engineering,"* xxi. 364.

Nut Wrench. A tool to be used in an ordinary brace, for the screwing on or off of bolt-nuts. Especially useful in carriage work.

Fig. 1823.



Nut Wrench.

Nut and washer gage, Fig. 7048, p. 2727, *"Mech. Dict."*

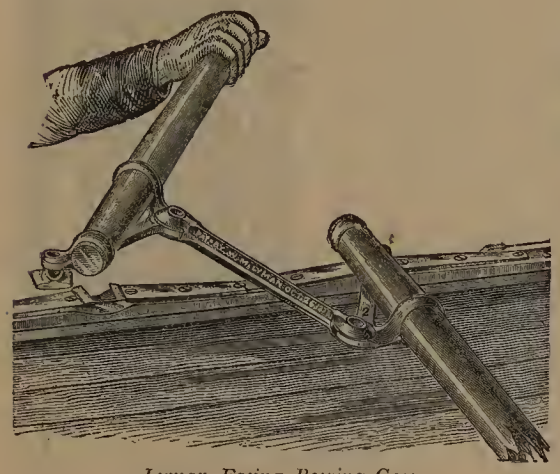
O.

Oar. The early notices of, and terms employed in, the handling of oars, are given on p. 1541, "*Mech. Dict.*"

The *Lyman* oar is a compound lever arrangement by which the oars are manipulated by a rower facing forward. Fig. 1824.

See also ROWING GEAR.

Fig. 1824.



Lyman Facing Rowing Gear.

Oat Mill. A machine for coarse-grinding oats.

The machines are of two characters: —

1. For grinding horse-feed; these are known as feed-mills or kibbling mills in England, and as *concasseurs d'avoine*, or *aplatisseurs*, in France. Their action is usually rather a crushing than a grinding operation.

2. Machines for the grinding of oats for gruel or porridge. The proper plan is to hull the oats, and then to pass them

Fig. 1825.

Oat Mill. (French.)

through a pointing machine which removes the fuzz on the point of the berry. This fuzz is said to produce an irritation of the skin which Byron mockingly calls "Sawney's violin."

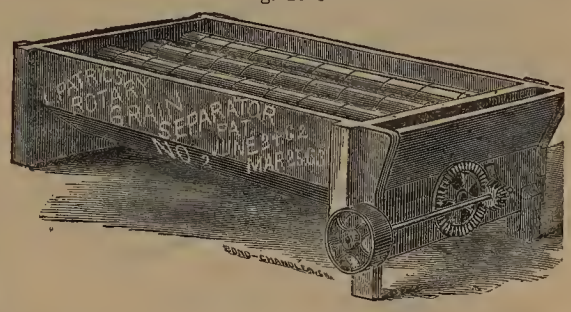
The French oatmeal machines (Beyer, Paris) proceed, however, directly upon the oats, by a double operation. The oats are passed between cylinders which simply flatten the grain without discharging any of the farina, and this product is then passed through the mill, which grinds it and discharges it into the sieves beneath, which sort it into qualities. See also * "*Scientific American*," xlii. 261.

A British form of oat-mill, *Biddell's*, is also double, but its duplicate parts are for simultaneous operation upon two grains for feed, — say oats and beans.

Oat Sep'a-ra'tor. A machine for removing from wheat the oats which are so frequently present in merchantable grain.

The grain is poured on to the slanting rollers which continually rotate and keep the berries in line; the thinner oats escape in the intervals between the rollers.

Fig. 1826



Rotary Oat Separator.

See also GRAIN CLEANER, Plate XX., opp. p. 416, *supra*, where a number of devices for this purpose are shown.

Ob'e-lisk. The obelisk, to be erected to Gen. John E. Wool, near Troy, N. Y., is to be 59′ height, 5.5′ square at base, 3′ square at top. To be erected on a pedestal 15.5′ high, on a foundation of 16′. Total 90′.

The following may be referred to for data on obelisks: —

Alexandria & N. Y.	"*Scientific Amer. Sup.*," xii. 322
Paper on Egyptian. *Cooper*	"*Scientific American Sup.*," 1887.
Paper by *Donaldson*	"*Scientific American Sup.*," 2002.
Elevating	* "*Scientific Amer.*," xxxvii. 328.
Launch of Cleopatra's needle	* "*Scientific Amer.*," xxxvii. 255.
Launch of the	"*Scientific American Sup.*," 1521.
Abandonment at sea	* "*Scientific Amer.*," xxxvii. 354.
Lowering of Alexandriau	"*Iron Age*," xxv., Jan. 15, p. 13.
Cleopatra needle vessel.	* "*Scientific Amer.*," xxxviii. 199.
Inscriptions on obelisk	* "*Scientific Amer.*," xxxviii. 199.
Taking down Cleopatra's needle	"*Scientific American*," xlii. 48.
Machinery	* "*Engineer*," xliv. 256.
Machinery for moving and raising	* "*Engineering*," xxvi. 409.
Placing on Thames embankment	* "*Scientific American*," xxxix. 55.
	* "*Harper's Weekly*," Oct. 26, 1878.
Cleopatra's needle (varnishing)	"*Scientific American*," xli. 26.
Vessel, Br.	* "*Engineering*," xxiii. 211.
Purpose, proportions, etc. "*Builder*," *Donaldson*	"*Van Nostr. Mag.*," xviii. 538.
Cleopatra's needle, Lond.	* "*Scientific American Sup.*," 2379.
	* "*Scientific American*," xxx. 215; xxxviii. 23.
	* "*Scientific American Sup.*," 1089.

See also MONOLITH, "*Mech. Dict.*" *et supra.*

A list of the remaining famous monolithic pillars of Rome is given under MASONRY, p. 586, *supra.*

O-blique' Fire. (*Fire-arms.*) That shape of action in which the plunger lies and strikes the ignition obliquely, that is, not parallel with the axis of the barrel.

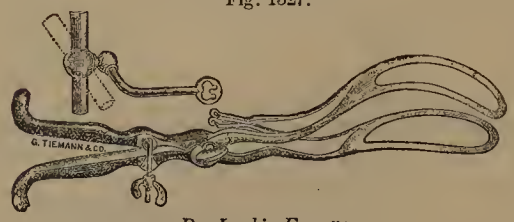
Ob-stet'ric For'ceps. A clasping prehensile instrument for assisting in difficult parturition. See Fig. 3363, p. 1543, "*Mech. Dict.*"

From a Guide Book to Pompeii: —

"*Maison des Grâces;* ainsi nommée d'une peinture des Grâces, avec Vénus et Adonis. A en juger par les instruments qu'on y a découverts (différentes espèces de forceps) on pense que c'était l'habitation d'un accoucheur."

Fig. 1827 shows *Dr. Lusk's* modification of the *Tarnier* obstetric forceps. The shanks have a peculiar forward

Fig. 1827.



Dr. Lusk's Forceps.

bend; a transverse screw crossing the handles below the lock; two movable traction rods attached to the inner curvature of the blades, and their outer ends inserted into a socket-rod joint belonging to a steel bar with a downward curve, and furnished with a transverse handle which has a universal joint, and by which alone tractions are made. — "*American Journal of Obstetrics*," April, 1880.

Fig. 1828.

Dr. Coles' Forceps.

Fig. 1828 shows *Dr. Coles'* obstetrical forceps.

Ob'tu-ra'tor. (*Add.*) 2. (*Ordnance.*) A gas check in a breech-loading piece; a Broadwell ring, for instance.

See remarks on the application of the obturator in an Austrian rifled cast-iron breech-loading howitzer of 21 cm. "*Ordnance Report*," 1878, Appendix L, p. 97, and Fig. 12.
Broadwell gas check, Fig. 1067, p. 448, "*Mech. Dict.*"

Oc'to-plex Tel'e-graph. (*Electric.*) One capable of sending 8 messages simultaneously over a single wire. An extension of the principle of the duplex, quadruplex, etc.

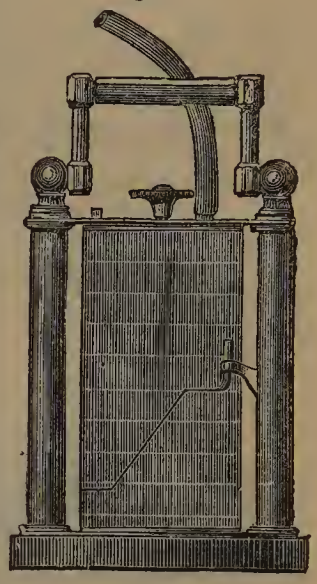
Klinkerfuss . . . . "*Scientific American*," xli. 306.

Oc'u-lists' Chair. One with special adaptations for operations on the eye.

The *seat* is adjustable for height.
The *back* for length, and for inclination.
The *head-rest* for angle.
The *cheeks* for distance, in clamping the head to hold it steady.
The *foot-rest* for length, height, and angle. *McIlroy.*

O'do-graph. An apparatus invented by M. Marey, for measuring the length and rapidity of man's strides in walking.

Fig. 1829.



Marey's Odograph.

It is a small instrument carried by the hand, and consists of a cylinder containing clockwork which causes the cylinder to revolve at the uniform rate of 2.36″ an hour. A pen is so arranged as to trace a line on paper rolled around the cylinder, and the track made by this pen shows the rapidity of the footsteps of the person to whom it is attached. An air valve is placed in the sole of the shoe, and it communicates with the instrument by means of a rubber tube leading up the trowsers' leg. Each time that the foot strikes the ground a slight puff of air is sent through the tube, causing the pen (which would otherwise mark only a horizontal line) to rise a distance equal to 0.004″. Thus a line is traced on the paper from left to right, rising at a greater or less angle with the horizontal according as the rapidity of the step is increased or diminished. If a man stepped exactly 3′ at each step it is evident that in going 3,000′ the pen would rise just 0.4″ but it was found in practice that the distance the pen was raised varied between 0.51 and 0.67″, showing that the average step varied in length from 2½ to 2′.

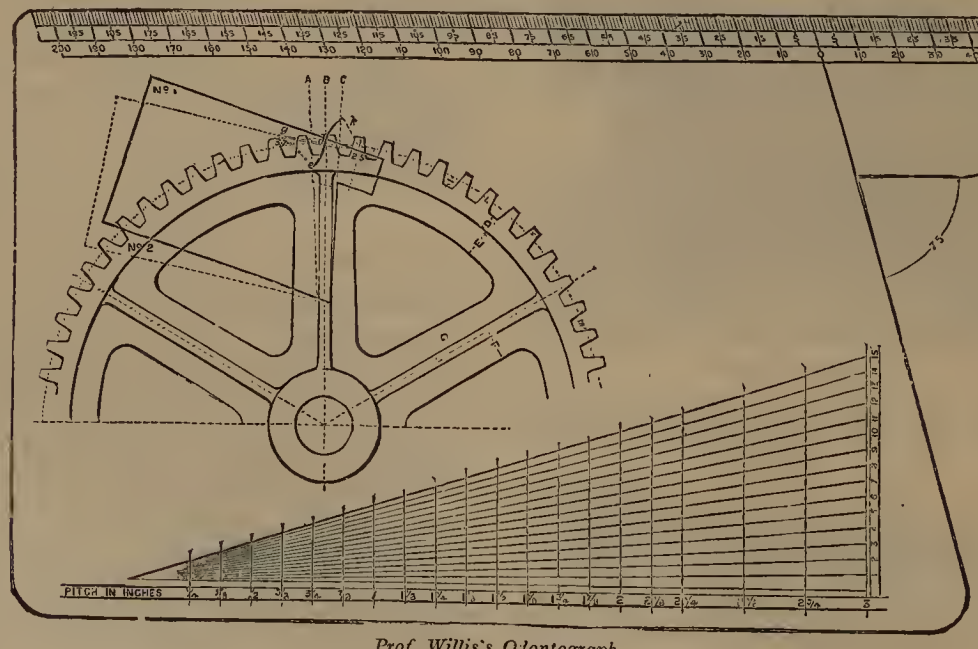
Odometer, *Gurley*, * "*American Man.*," July 25, 1879, p. 12.

O-don'to-graph. An instrument for setting out the forms of teeth of gear wheels.

By the use of Prof. Willis's instrument, shown in Fig. 1830, and tables of the *centers for the roots*, and *centers for the tops or faces*, the circular tops and roots of teeth can be readily drawn, and, considering the shortness of the arc, the shape of the tooth approximates very closely to the true epicycloidal form, and is quite correct enough for all practical purposes.

Fig. 1830 shows how the instrument is used. The wheel

Fig. 1830



Prof. Willis's Odontograph.

selected as an example has 61 teeth, 3″ pitch. Having found the diameter of the pitch line of the wheel required, and this diameter being described, set out $A\ C =$ to the pitch of the tooth, and draw the radial dotted lines as shown; bisect these by another radial line, *B*. For the root of the tooth, place the instrument as indicated in No. 1, and in the Table for the Roots of Teeth, which is the number nearest to that required, and in the column for 3″ pitch, will be found 37. This point must be pricked off at *g*, and the arc *d e* described. This gives the proper form for the root of the tooth. The instrument is then moved into the position indicated by the dotted lines No. 2; and 25 being the number given opposite to 60 in the column for 3″ pitch in the Table for Tops of Teeth, this point is pricked off as above described, and from the point *h* the arc *k d* is described. This gives the proper form for the top or face of the tooth.

When fixing the points *g* and *h*, it must be remembered that they will be found on *opposite* sides of the radial arm of the instrument.

Internal Gear. — In setting out internal gear the rule is inverted, the curve for the root becoming that which is given for the top in the foregoing instructions for using the instrument.

Rack Gear. — For setting out racks the pitch line becomes a straight line, and the instrument is applied to perpendiculars drawn on it equal to the pitch.

The numbers for pitches not given in the Tables may be found by doubling or dividing the numbers of a given pitch. As examples, if 4″ pitch is required, double the number given for 2″ pitch; or if ½″ pitch is required, take half that given for 1″ pitch.

The diagonal scale, at the lower part of the figure, gives the proportions of the various parts of wheels. These proportions give good results for wheels of ordinary dimensions; but modifications are required for very small or very large wheels. — *Appleby.*

CENTERS FOR THE ROOTS OF TEETH.

No. of Teeth.	Pitch in Inches.							
	1	1¼	1½	1¾	2	2¼	2½	3
13	129	160	193	225	257	289	321	386
14	69	87	104	121	139	156	173	208
15	49	62	74	86	99	111	123	148
16	40	50	59	69	79	89	99	191
17	34	42	50	59	67	75	84	101
18	30	37	45	52	59	67	74	89
20	25	31	37	43	49	56	62	74
22	22	27	33	39	43	49	54	65
24	20	25	30	35	40	45	49	59
26	18	23	27	32	37	41	46	55
30	17	21	25	29	33	37	41	49
40	15	18	21	25	28	32	35	42
60	13	15	19	22	25	28	31	37
80	12	15	17	20	23	26	29	35
100	11	14	17	14	22	25	28	34
150	10	13	16	19	21	24	27	32
Rack	10	12	15	17	20	22	25	30

CENTERS FOR TOPS OR FACES OF TEETH.

No. of Teeth.	Pitch in Inches.							
	1	1¼	1½	1¾	2	2¼	2½	3
12	5	6	7	9	10	11	12	15
15	5	7	8	10	11	12	14	17
20	6	8	9	11	12	14	15	18
30	7	9	10	12	14	16	18	21
40	8	9	11	13	15	17	19	23
60	8	10	12	14	16	18	20	25
80	9	11	13	15	17	19	21	26
100	9	11	13	15	18	20	22	26
150	9	11	14	16	19	21	23	27
Rack	10	12	15	17	20	22	25	30

PROPORTIONS OF WHEEL SHOWN IN FIG. 1830.

I = Depth of tooth below pitch line . . $= \frac{6}{15}$ P.
K = Height of tooth above pitch line . . $= \frac{5}{15}$.
L = Breadth of tooth above pitch line . . $= \frac{7}{15}$.
M = Width of space between teeth . . . $= \frac{8}{15}$.
D = Thickness of rim below the teeth . . $= \frac{7}{15}$ P.
E = Depth of rib of rim . . . . . $= 1$ P.
F = Width of arm from feather . . . . $= 1$ P.
G H = Thickness of metal . . . . . $= \frac{7}{16}$.

Robinson . . . . . * "*Min. and Sc. Press*," xxxiv. 105.
"*Scientific American*," xxxv. 181.
Willis . . . . . * "*Van Nostrand's Mag.*," xv. 1.

O'dor-less Ex'ca-va'tor. A pump, tank, and consumer of odor, to remove inoffensively the contents of cesspools.

See CESSPOOL PUMP, Fig. 584, p. 187, *supra.*
"*Scientific American Supplement*" . . . . . 978.

Œ-de'ma Glot'tis Tube. (*Surgical.*) See EDEMA GLOTTIS TUBE.

Off'-bear-ing Bar'row. The barrow in a brick yard, plying between the molding bench and the hack. See Fig. 2351, p. 1046, "*Mech. Dict.*"

Of'fice Watch'man. An instrument to keep record of the periodical visits of a watchman in a building or yard.

See WATCH CLOCK, Fig. 7080, p. 2733; WATCHMAN'S TIME DETECTOR, Figs. 7083, 7084, p. 2734, "*Mech. Dict.*"

Off'set. (*Carriage Hardware.*) The fork at the point in the back-stay where the branches separate to reach the hind axle at two points.

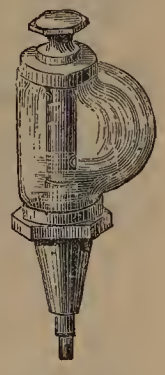
Fig. 1831.

Offsets.

a. Round offset.
b. Point octagon offset.
c. Oval offset.

Off'set Glass. A journal oiler having a glass globe, the bulge of which is on one side in order to allow the glass to stand in a place close up to the side of an object.

Fig. 1832.



Offset Glass.

Off'set Pipe. A pipe to pass an obstacle, bending aside, and then resuming the original direction.

Several examples may be seen in Fig. 295, p. 97, *supra.*

Ohm. (*Electricity.*) A measure of electric force or resistance equal to 1,000,000,000 centimeters per second. Ganot's "*Physics*," p. 832. Named from the electrician Ohm, a German savant. The law governing the relations of current, electromotive force and resistance is known as *Ohm's law.*

The Electrical Congress in Paris, 1881, determined that the *ohm* should be represented by a column of mercury of a square millimeter section at 0° Centigrade. A committee was appointed to ascertain and report the height of such column in millimeters.

Oil Box. (*Railway.*) The journal-box, or axle-box of a car-wheel.

Oil Bush. A socket in which an upright spindle works, and which holds a quantity of oil, so

that the spindle runs in oil, as in the Noyes oil-bush spindle for mill-stones.

Oil Cake Break'er. A machine for grinding oil cake as food for stock.

See CAKE BREAKER, Fig. 498, p. 152, *supra;* OIL CAKE BREAKER, Fig. 3369, p. 1547, "*Mech. Dict.*"

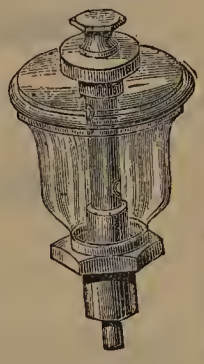
Oil Cans, etc. See:—

Cabinet, *Thayer*	* "*Scientific American*," xli. 382.
Can, *Moran*	* "*Scientific American*," xl. 150.
Can nozzle, *Hasenritter*	* "*Scientific American*," xxxiv. 274.
Can, suspended, *Graves*	* "*Scientific American*," xxxvii. 54.
Car	"*Scientific American Sup.*," 737.
Cleansing app., *Koellner*	* "*Scientific American Sup.*," 4108.
Cotton-seed oil	"*Scientific American*," xxxvi. 229.
Cylinder, *Siebert*	* "*Amer. Manuf.*," July 11, 1879, p. 16.
Cup, *High*	* "*Scientific American*," xxxv. 194.
Engine	* "*Manufact. & Builder*," x. 9.
Feeder, "American"	* "*Iron Age*," xix., June 14, p. 5.
Lubricants	"*Scientific American*," xliii. 404.
Oiler, *Eason*	* "*Scientific American*," xl. 85. * *Laboulaye's* "*Dict.*," ii., "*Graissaye*," Figs. 1001-1007.
Barkus	* "*Scientific American*," xxxiv. 291.
Tank protector	* "*Scientific American*," xliii. 308.
Storage, *Shaw*	* "*Manufact. & Builder*," xii. 175.
Testers.	See LUBRICANT TESTER, *supra;* OIL TESTER, *infra.*
Wells, *Baker*	"*Scientific American Sup.*," 107.
Of Burmah, *Robertson*	"*Scientific American Sup.*," 4049.
Process of sinking	"*Scientific American Sup.*," 1969.

Oil Cel'lar. (*Railway.*) A cavity in the lower part of a journal box for collecting the oil and dirt which runs off the axle at the dust-guard. — *Forney.*

Oil Cup. A lubricator placed over a journal or on a cylinder to oil the piston.

Fig. 1833.



Oil Cup.

The forms are various and may be found under: NEEDLE LUBRICATOR; OILER LUBRICATOR; TALLOW CUP, etc., in "*Mech. Dict.*," and herein.

The form shown in Fig. 1833 is a glass cup mounted on brass, provided with a hollow tube, inside of which is placed a loose-acting, solid or hollow wire, which rests upon the journal and acts as a feeder and regulator.

Oil En'gine. A name for the HYDRO-CARBON ENGINE, which see, Fig. 1420, p. 484, *supra.*

Oil'er. A LUBRICATOR. See TALLOW CUP; OIL CUP; OIL GLOBE, etc.

The oiler for wool is attached to the first breaker card.

Oil Gage. An instrument usually of hydrometer form for ascertaining the specific gravity of oils, and thereby obtaining data by which to estimate their purity.

Plunge the instrument in the oil, give it time to acquire the temperature of the oil, and then observe the degree of the thermometer, as well as the degree of the hydrometer. If the thermometer is at x degrees *above* zero, an equal number of degrees must be deducted from the hydrometer degree. If the thermometer is at x degrees *below* zero, an equal number of degrees must be added to the hydrometer degree. The range of the hydrometer scale is from 22 to 50, and the following table shows the degree of certain common oils:—

Purified rape oil	38-39
Common rape oil	37-38
Olive oil	37-38
Dötter oil	32-33
Poppy oil	32-33
South sea train oil	33
Nut oil	32-33
Hempseed oil	30-31
Linseed oil	29-30

Mixtures of oils show a mean density. Oils that have been purified are rendered lighter, and show about 1° more on the instrument.

Oil Globe. A form of oiler having a globular oil chamber. In the instances shown, the devices have three cocks: one between the funnel and the chamber, one between the chamber and the steam cylinder, a third allows air to escape from the chamber when filling.

Fig. 1834.

Oil Globes.

Oil Line Pipe. A pipe laid for conveyance of petroleum. It was first introduced by S. Vansyckle, who laid a 2″ tube, 6 miles in length, in 1865. The United Pump Co. laid a 3″ pipe in 1873.

The following is the total mileage of iron pipe used for conveying oil in the oil regions of Pennsylvania:—

Lines.	Size of Pipe. 2-in.	Size of Pipe. 3-in.	Total Miles.
	miles	*miles.*	
Atlantic Pipe Co.	80	10	90
American Transfer Co.	50	22	72
Ant. and Oil City Pipe Co.'s	–	–	136
Brady's Bend Iron Co.	1½	–	1½
Church Run Pipe Co.	6	–	6
Charley Run Pipe Co.	1⅛	–	1⅛
Cherry Tree Run Pipe Co.	25	–	25
Columbia Conduit Co.	71	51	128
Conewango Pipe Co.	5	–	5
Franklin Pipe Co.	9	1	10
Grant Pipe Co.	120	–	120
Hunter & Cummings Pipe Co.	5	½	5½
Karns Pipe Co.	82	–	82
Keystone Pipe Co.	30	–	30
Milton and Sandy Pipe Co.	52	1	53
McKean County Pipe Co.	16¾	–	16¾
New York Pipe Co.	40	–	40
New York and Alleghany Oil Co.	5	–	5
Octave Pipe Co.	20	–	20
Olean Pipe Co.	33	–	33
Pennsylvania Transportation Co.	380	–	380
Prentice, F. & Co.	¾	–	¾
Pacific Pipe Co.	2	–	2
Private Pipe (Foxburg)	2	–	2
Richard Jennings Pipe Co.	3	–	3
Relief Pipe Co.	100	–	100
Rochester and Oleopolis Co.	30	3	40
Sage Run Pipe Co.	5	–	5
Shaffer Run Pipe Co.	1⅛	–	1⅛
Smith's F'y & I. Run Co.	5	–	5
Titusville Pipe Co.	40	–	40
Tidioute Oil Pipe Co.	11	2	13
Taft & Payne Pipe Co.	10	–	10
Union Pipe Co.	300	–	300
United Pipe Co.	276	24	300
Total mileage		–	2,081¾

The following is the mode of collecting the oil by means of the pipe lines and loading it into the cars: The pipe used is of wrought-iron lap welded, usually two inches in diameter, put together with a screw-sleeve joint. The main pumping line or lines are run from the center of production by the most direct route to the railroad station. The pipe is laid along the surface of the ground, except at road crossings or where protection is necessary. At the railroad large iron receiving tanks are erected varying from 5,000 to 20,000 barrels capacity each. These tanks are placed at a sufficient

elevation above the railway to permit their contents to be run by gravity through pipes to the loading racks where the cars stand in sidings adjacent. At the necessary intervals along the pipe line, pumping stations are established for the reception and forwarding of the oil. The equipment of the main stations consists of a pump house, with two or more powerful pumps worked by steam; two tanks of from 500 to 2,000 barrels capacity each in a tank house; a telegraph office and a building to accommodate the employée in charge. From each such station, branch connecting lines lead off in every direction to the hundreds of wells that are tributary to it. At each well accurately gaged storage tanks are fixed to which the pipe line branches are attached. Before commencing to draw oil from these tanks their contents are measured and recorded; another measure and record is made after the pipe line ceases taking oil from them, and the difference in inches between the two measures forms a basis of credit to the well owner in the company's books. A memorandum receipt, known as a gager's ticket, is given to the well owner at the time the oil is run into the pipe line, and becomes a negotiable certificate. All petroleum received goes into a common store, from which deliveries are made in accordance with orders received from the owners.

"The average capacity per 24 hours of a single main of two-inch pipe may be considered as about 40,000 gallons. From 1866 to March 31, 1876, the oil passed through the Empire Transportation Company's pipes amounted to 375,810,551 gallons of crude petroleum. The quantity of petroleum held in store in tanks located in the Pennsylvania oil region may be stated as averaging from 80,000,000 to 120,000,000 gallons. In case of the conflagration of an oil tank the loss is shared by the owners, in the ratios of the relative quantities of the oil held for them at the time. From Karns City to the Alleghany Valley Railway the charge made for the use of the pipe line was 30 cents per barrel, an allowance of a little over two per cent. being made for leakage and waste."—*Capt. Galton.*

Pipe lines, statistics of . "*Eng. & Min. Jour.*," xxii. 299.
"*Scientific American*," xxxv. 130.
"*Sc. American Sup.*," 737, 796.
Line pump . . . . . * Fig 5725, p. 2359, "*Mech. Dict.*"

Oil Press. A press for extracting oil from seeds, fruits, fatty matters, etc. See:—

Lard Press, Fig. 2811, p. 1255, "*Mech. Dict.*"; Hydrostatic Press, p. 1156, *Ibid.*
See Olive Press, *infra.*
See also Hot Press (stearine), Fig. 1386, p. 471, *supra;* Oil Press, Figs. 3383, 3384, pp. 1534, 1535, "*Mech. Dict.*"; Stearine Press, *infra;* Screw Press; Wedge Press, "*Mech. Dict.*"

Oil Pump. 1. A pump for oil wells, usually very deep.

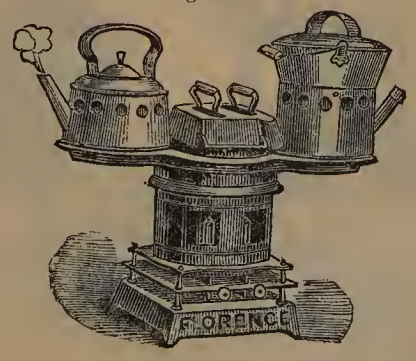
See Deep Well Pump, Fig. 1604, p. 683, "*Mech. Dict.*"; Ejector, Figs. 1833-1835, p. 775, *Ibid.*; Well Apparatus, Plate LXXIV., p. 2758, *Ibid.*

2. A pump for oil pipe lines. Fig. 5725, p. 2359, *Ibid.*

Oil Stone. A report on whetstones and oil-stone was made by *J. M. Safford*; "*Centennial Exhibition Reports*," Group I., vol. iii., p. 172, *et seq.*

Oil Stove. A stove heated by petroleum.

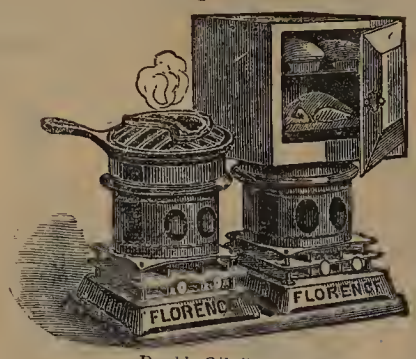
Fig. 1835.



Single Oil Stove.

Figs. 1835, 1836, show two forms, heated by lamps burning kerosene. One has a three-hole top on a single stove, and the other has two stoves on a common base.

Fig. 1836.



Double Oil Stove.

Refer to:—
Adams & Westlake . * "*Eng. & Min. J.*," Aug. 2, 1879, p. 10.
Cooking, "Summer comfort" . . . . . * "*Iron Age*," xix., April 5, p. 5.
"Faëry Queen" . . . * "*Iron Age*," xix., June 7, p. 24.
Whitney & Hall . . * "*Iron Age*," xix., June 28, p. 9.

Oil Test'er. 1. A machine for testing the lubricity of oils. See Lubricant Tester. See also Fig. 6330, p. 2539, "*Mech. Dict.*"

2. Apparatus for testing explosive points of burning oils. See Petroleum Tester. See also Fig. 3666, p. 1676, "*Mech. Dict.*," Figs. 6317, 6318, p. 2536, *Ibid.*, and memorandum on p. 1558, *Ibid.*

A simple test for the presence of free acid in machine oils consists in pouring the oil to be tested over a layer of cuprous oxide contained in a glass. (The ash of the coppersmith answers the purpose, since it contains this oxide.) If the oil contains either free, fatty, or resinous acid, the same will attack the oxide and color the oil green in a very short time. Slightly heating accelerates the action, which manifests itself in less than half an hour. This test is said to be very delicate, and more satisfactory than any hasty test heretofore devised.

Testing mach., *Ashcroft* * "*Railroad Gazette*," xxii. 511.
Testing for acids . . . "*Iron Age*," xxi., May 23, p. 15.
App., *Ingram & Stapfer* * "*Scientific American Sup.*," 1073.
* "*Engineering*," xxiii. 28, p. 33.
Mead . . . . . * "*Scientific Amer.*," xxxiv. 402.
Millspaugh . . . . * "*Scientific Amer.*," xxxiv 182
Pease . . . . . "*Scientific American*," xlii. 323.
Thurston . . . . . * "*Engineering*," xxiii 176.
* "*Manufact & Builder*," ix. 59.
Cleveland, *Withycombe* . * "*Railroad Gazette*," xxi. 266.
See also Lubricant Tester.

Oil'-well Pump. A pump for deep wells of narrow bore. See references under Oil Pump, *supra.*

In the *Douglas* pump, Fig. 1837, the stuffing box head has a branch pipe on which to connect the discharge pipe that leads to the tank. Forked metallic connections are screwed on to the short connecting-rod in the stuffer head and to the piston, and are themselves connected by a wooden rod to which they are attached. The piston has a brass ball valve. Threads are cut on the stuffing box head, and the lower cylinder, so as to screw on iron pipes between to lengthen out the pump to suit wells of any depth.

O-i'ron-ware. (*Ceramics.*) See Faïence d'Oïron; Henri-Deux Ware, *supra.*

O'le-o-jec'tor. A name adopted by the inventor, Mr. Royle, for a new form of cylinder and slide valve lubricator.

The apparatus has an elevated reservoir from which the oil drips, drop by drop, into the cup. A valve closes against internal pressure, and at each recurrence of low pressure a jet of steam drives the oil in a spray into the chamber or cylinder.

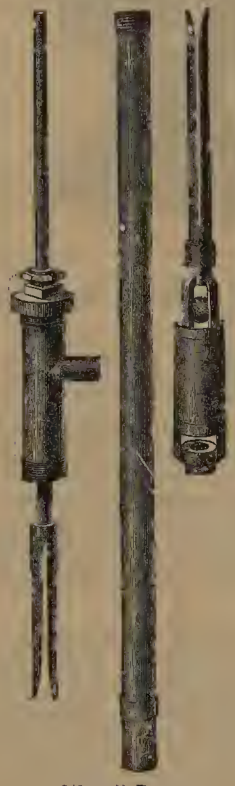
"*Engineering*" . . . . . xxx. 294.
"*Engineer*" . . . . . i. 281.

O-le-om'e-ter. An instrument on the Gay Lussac hydrometer principle, for testing the relative gravity of oils.

It has a weighted air bulb and graduated stem, and does not differ from other meters of its class, except in proportion and the index of graduations.

Another test of the purity of oils proceeds by observation

Fig. 1837.



Oil-well Pump.

Fig. 1838.

Oleometer.

of the tints of oils by adding a drop of concentrated sulphuric acid to 10 or 15 drops of the given oil on a glass plate, covering with white paper, and observing the tints produced: the method of M. Heydenreich, of Strasburg. The results obtained are affected, however, by the age of the oil; in some degree by the mode of its extraction; some oils give the same indications, and mixtures give curious combined results difficult to read.

LEFEBVRE'S TABLE OF DENSITIES OF OILS, FRESHLY PREPARED, TEMPERATURE, + 15° C.

Oils.	Density, Water, 10,000.	Weight. Per Hecto-liter.	Weight. Per Liter.
		Kilos.	*Grams.*
Sperm	8.840	88.40	884.
Oleic acid	9.003	90.03	900.3
Winter colza	9.150	91.50	915.
Winter turnip seed	9 154	91.54	915.4
Summer turnip seed	9.157	91.57	915.7
Neats' foot	9.160	91.60	916.
Summer colza	9.167	91.67	916.7
Earth nut	9.170	91.70	917.
Olive	9.170	91.70	917.
Sweet almond	9.180	91.80	918.
Beech nut	9.207	92.07	920.7
Grape seed	9.210	92.10	921.
Sesame	9.235	92.35	923.5
Whale	9.240	92.40	924.
Poppy seed	9.253	92.53	925.3
Hemp seed	9.270	92 70	927.
Cod liver	9.270	92.70	927.
Skate liver	9.270	92.70	927.
Cameline	9.282	92.82	928.2
Cotton seed	9.306	93.06	930.6
Flax seed	9.350	93.50	935.

See also tables and lists, pp. 1551-1553, "*Mech. Dict.*"

The instrument of Lefebvre, of Amiens, Fig. 1838, has a relatively large cylindrical air-chamber and a long stem. The latter is graduated for densities comprised between 9,000 and 9,400, which includes the principal oils of commerce. The figuration on the scale comprises actually only the two middle figures, the units and thousands not being shown.

For example: colza oil shows "15" on the scale. It is necessary to read 9(15)0 for the density; or 91.50 kilos for the weight per hectoliter; or 915 grams per liter.

On the left of the line of the graduations are the names of the oils. Thermometrical corrections are made by table. Adulterations give indications between the two oils so combined, according to their relative densities, and proportional quantities. The test is much complicated by the settling of the heavier oil to the bottom as the mixtures are unstable. Poppy-seed oil, mixed with olive oil, will form a lower stratum in 8 days of repose.

Earth-nut and olive oil have the same weight; hemp seed and cod-liver oil are also equal.

The oleometer of Laurot, of Paris, is for testing by means of ascertaining the density at the boiling point of water in a bath of which the vessel of oil is placed. At the temperature 100° C., the oils differ more in relative densities. The instrument of Gobley, *Elaïometre*, is designed simply to test the presence and quantity of poppy-seed oil in olive and almond oils.

See *Laboulaye's* "*Dictionnaire des Arts et Manufactures*," iii., "*Oléomètre.*"

Olive Press. A toggle-press for olive pressing was exhibited at the Paris Exposition, in 1878, by Samain, of Blois, France, and is shown in Fig. 1839.

It is capable of being worked by hand or steam, though the pulley is not shown in the cut. It is an eminently compact arrangement, even in that land of fruit and presses.

For the lower power the machine is worked by the crank, but when the higher power is required the upper handles are used to extend the arms of the toggle-levers. This flexor and extensor movement is found in some of our own presses, and is both powerful and compact.

A sheet-iron barrel is shown in the press, and the tampon is of a corresponding shape. Fig. 1840, however, shows a cast-iron square box or caisson for containing the olives; tho wooden plug or tampon which enters the box and expresses the oil towards the side as well as downward; also the sheet-iron barrel with perforated sides.

Fig. 1840.

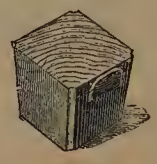
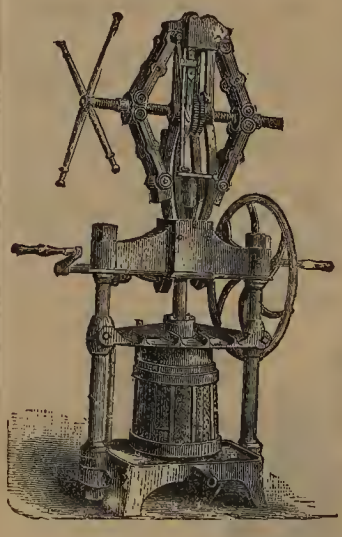
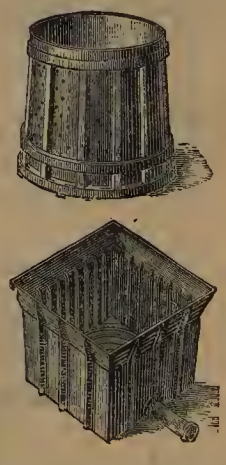


Fig. 1839.



Toggle Press for Olives.
(Samain of Blois.)

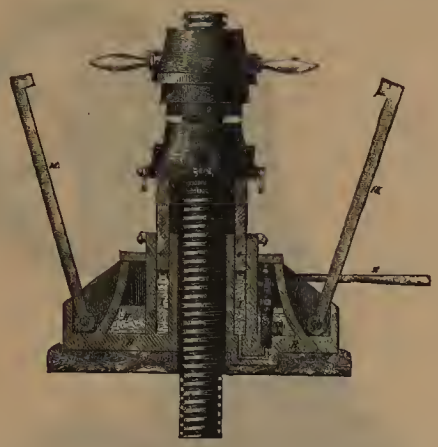


Samain's Caisson, Tampon, and Barrel for Oil Press.

A very compact combination of the screw and hydraulic press is made by Cassan Fils, of Jallieu, near Bourgoin (*Isère*), the hydraulic mechanism being in the sole of the pressure-block beneath the nut on the screw of the press.

The vertical fixed screw has two nuts, *L* and *J*. When high pressure is to be applied, the tank *H* is filled with wa-

Fig. 1841.

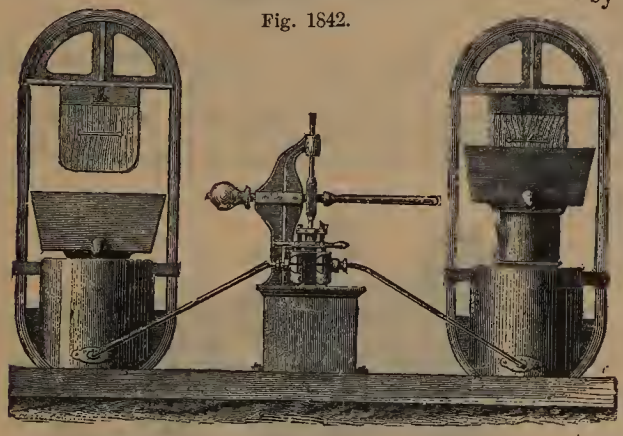


Combined Screw and Hydrostatic Press. (*Cassan, fils, Jallieu.*)

ter, the valve of egress closed, and the lever *E* of the pump worked. The sole *B* descends as the water from the cistern *H* is driven by the pump *D* into the cylinder *I* beneath the piston *C*. As soon as the circular mark *O O* appears, the course of the piston is complete.

To sustain the pressure, the props *M M* are brought beneath the nut *L*, which is adjusted in height to suit the occasion. The exit-valve of the cylinder is opened, and the water returns into the tank *H*. The nut *J* and the piston *C* then descend until the latter is at the bottom of the cylinder. The valve is then closed, the pump worked, and the sole *B* driven down again as before.

Fig. 1842.

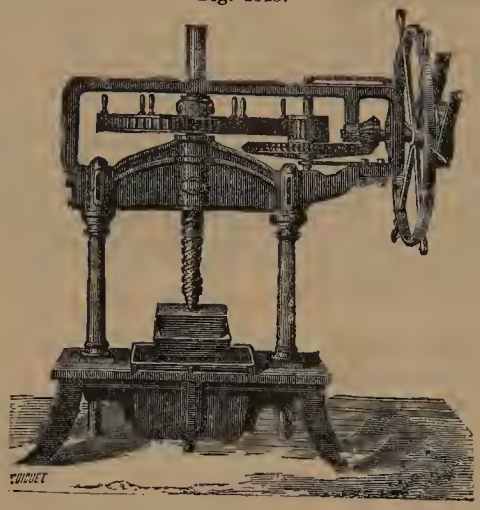


Hydraulic Oil Press. (*Mannequin, Troyes.*)

Fig. 1842 shows a compact hydraulic press by Mannequin, of Troyes, France. It is intended for nut oil, colza, rape, and turnip seed.

The follower enters the basin, which is on the summit of the piston of the hydraulic press. The pistons are worked alternately by a single pump. The press is adapted for wine, for the extraction of the oils of seeds, nuts, olives, and fish, and also for use in suereries, paper, and soap factories. Its power varies according to the purpose for which it is constructed, from 1,000 to 200,000 kilos.

Fig. 1843.



Press with Gearing. (*Mabille, Frères.*)

Fig. 1843 is a press operated by gearing, either by hand or power.

The press has two speeds: First by levers in the pins of the master wheel, and secondly, by the hand-wheel and system of gearing. The capacity is stated as yielding from 15 to 20 liters each filling, requiring 20 minutes for perfect extraction; 30 trips per day at 20 liters = 600 liters per 12 hours without reheating the cakes.

Olives . . . . . "*Scientific American Sup.*," 1912.

One'-horse Mow'er. A mower of relatively small size, adapted to be drawn by one horse. That shown in Fig. 1844 has driving wheels 30″ high, and cuts a swath 3.5′.

One'-legged Rail'way. A railway supported on a single row of posts, adapted to be traversed by a saddle-shaped car.

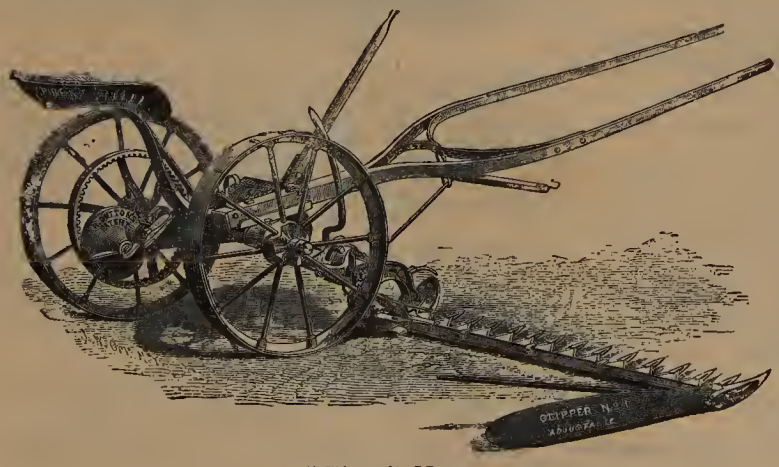
Used in the Bradford oil region.

One form was shown in operation in Fairmount Park, at the Centennial. See also Figs. 1856, 1857, pp. 792, 793, "*Mech. Dict.*," "*Scientific American*," xxxviii. 22.

See also One-rail Railway; Uno-rail Railway, *infra.*

One'-light Reg'u-la'tor. (*Electricity.*) An order of regulators for voltaic arc lights, adapted to a single light; as distinguished from a *many-light*, or *polyphote* regulator. Usually called a *monophote* regulator.

Fig. 1844



"*Clipper*" *Mower.*

One'-rail Rail'way. One in which the car travels saddle-fashion upon a single rail. Instances are given in Fig. 1856, p. 792, "*Mech. Dict.*" See also One-legged Railway.

A one-rail railway in the oil regions of Pennsylvania is 6 miles long.

The car is not unlike an ordinary passenger car in appearance. It is 28′ long, 8′ 2″ wide, with seats running lengthwise of the car, as in street cars. Underneath the car, and running its entire length, are two sections or boxes, flush with the outer sides of the car, with sufficient space between them for the wheels and the rail they travel on. The sections serve to balance the car upon the rail, and also for the carriage of baggage. Transversely, below the floor at each end of the car are the axles of the 34″ double-flanged wheels, the upper portions of the latter being boxed in, while the lower rest on the rail. The rail is

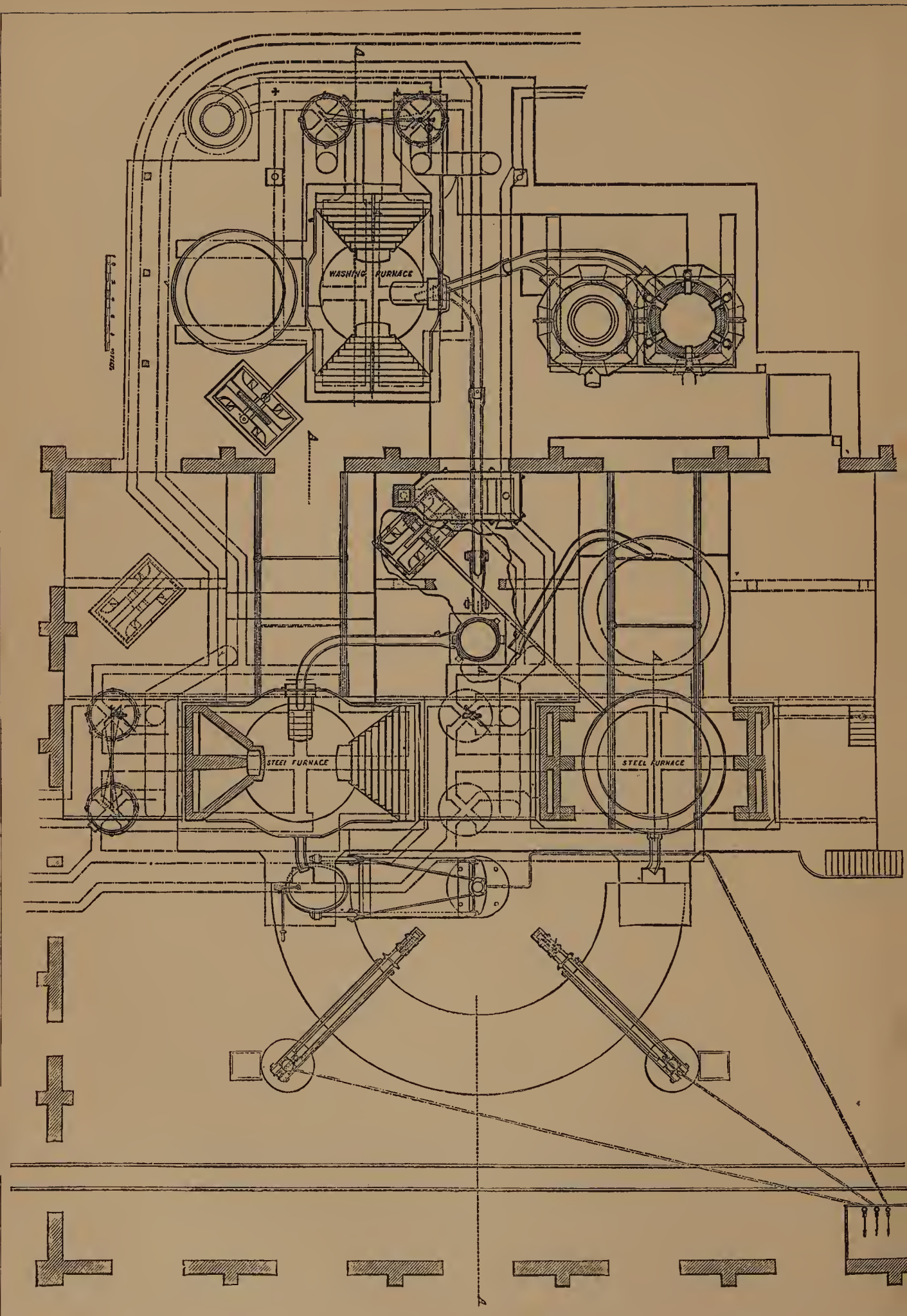


PLATE XXXI. THE "PERNOT" OPEN HEARTH FURNACE, SPRINGFIELD IRON WORKS, SPRINGFIELD, ILLINOIS. *See page 643*

(General plan of open hearth plant.)

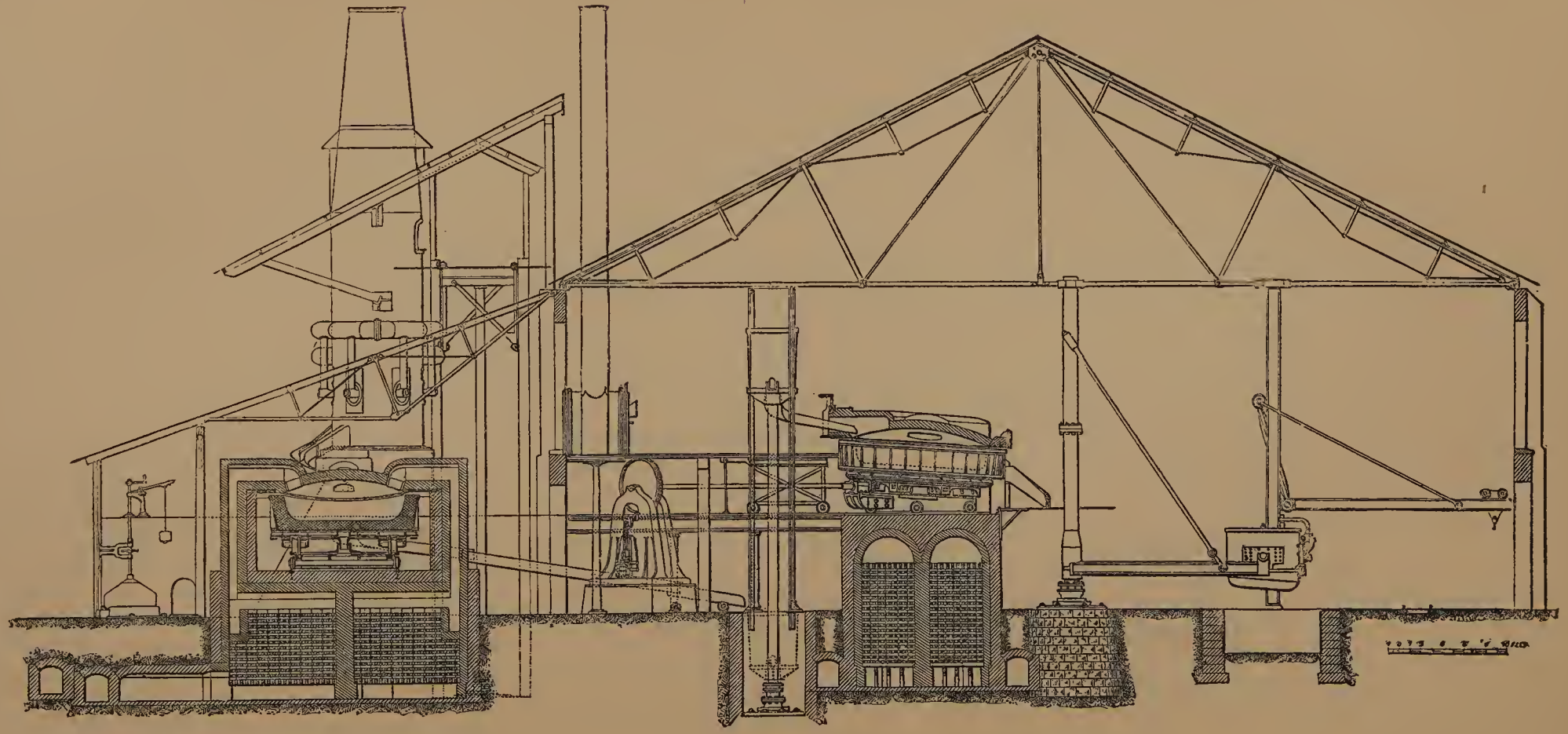


PLATE XXXII.

THE "PERNOT" OPEN-HEARTH FURNACES, SPRINGFIELD IRON WORKS, SPRINGFIELD, ILL.

Vertical section on lines A A A, Plate XXXI.

See page 645.

ble hearth and is worked by the Siemens' regenerative furnace.

This regenerative furnace is shown in Figs. 1159, 1160, p. 386, *supra*; and the Ponsard regenerator in Figs. 1161, 1162, p. 387, *Ibid.*

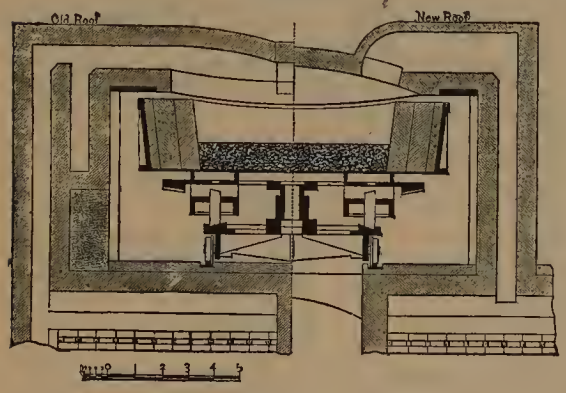
The materials employed are various: melted or unmelted pig with ore, and with or without scrap; pig iron purified from silicon and phosphorus, with or without scrap; pig iron and scrap, remelted together in a cupola, or charged hot or cold, together or separately, into the steel furnace; a pig-iron bath, and hot or cold steel or iron scrap, direct sponge or Catalan or puddled blooms charged into the bath.

The operation is, to a greater or less extent, according to the nature of the materials used, a desiliconization and decarburization of the pig iron and its dilution by already purified materials. Manganese is employed at the end of the operation to remove oxide of iron and silica, a regulated amount of manganese remaining in the product.

The Pernot hearth is shown in the engraving with its old form of roof on the left, and its new form on the right. The new roof is a flat dome, resting upon a continuous skew back, which is supported by the circular iron frame.

The hearth has a plate-iron bottom, the sides being cast-iron staves secured by an upper ring, and easily replaced. The hearth stands on a cast-iron spider, which only touches

Fig. 1848.



Pernot's Open-hearth Furnace.

the bottom plate at points, so that the spider does not get hot; the oil on the wheels is not burned, and no water is ever played upon any part of the apparatus to keep it cool. The spider rests upon four or six conical wheels, which roll on a circular railway cast upon the frame of a car. The car and the bottom may thus, at any time, be pulled out from under the roof. A small steam-engine, situated behind the furnace, drives a small gear which engages a large gear bolted in segments to the spider. The axis of the hearth is inclined 5° or 6° from the vertical, and the speed of rotation is three or four revolutions per minute. A roll train coupling on the driving shaft may be quickly disengaged when the hearth is to be drawn out.

The joint between the revolving hearth and the stationary roof is simply a 3″ space filled with fire-sand, excepting a mere slit at the top, which forms a perfectly efficient packing.

The roofs and the sides of the hearth are made of silica brick. The bottom of the hearth is of fire-sand, rammed hard while the hearth is out. It is more durable and more easily set than the stationary bottom.

Each 8-ton furnace has four producers of the ordinary Siemens pattern and size.

The Pernot open-hearth of the Springfield Iron Company, of Springfield, Ill., is shown in Plates XXXI., XXXII.

This company, as Mr. A. L. Holley observed, was the first in the United States to adopt the Krupp process of washing phosphorus out of pig iron, and the second to introduce the Pernot revolving and movable hearth. The full plant of the open-hearth furnaces is shown in the plates, which are respectively a plan and vertical section.

The pig is melted down in the cupolas shown on the upper left hand, Plate XXXII., and run through a gutter to the revolving Krupp washing furnace near it. After being purified, the metal is tapped and transferred to the Pernot steel furnace. In this it is converted into steel, which is tapped into the ladle shown in position over the pit. The steel is finally cast into ingots.

The following description is by Mr. Holley: "The furnaces stand high enough to give a roomy and well ventilated floor all around them on a general level, and also a conveniently shallow casting pit. The upper part of the regenerators, and also the reversing valves, stand accessibly above ground. The charging floor and appurtenances are on the opposite side from the casting department.

"Casting is done by means of an ingot crane of large radius, rather than by the less convenient and less easily moved ingot car. There is a platform in front of the furnace for dressing the tap hole. The arrangement is such that the ladle may be moved over the ingot molds; or steel may be running into the ladle, and at the same time out of the ladle into a group of molds.

"The furnaces stand in a single line, and not in a double line, which gives a concentrated stock-yard and a producer-house (reached by the same elevated railway system) on one side, and a cool casting house and an ample ingot yard on the other side.

"The chief advantage of the revolving hearth is mechanical agitation, which facilitates the chemical reactions. The obvious and important advantage of the removable hearth is convenience and economy of repairs. The ordinary repairs do not, as in the case of the stationary hearth, interfere with the continuous production of steel.

"The sustaining and revolving gear of the hearth are not materially changed from M. Pernot's designs, except that a water-cooled center pintle has been provided to resist the lateral thrust of the hearth. The hearth must necessarily be run out for repairs, not only on the charging side, but through the charging floor. In order to avoid the trouble of taking up the charging floor when the hearth is run out, that part of the floor behind the hearth is placed on a carriage that rests on the same railway that sustains the hearth.

"The arrangement of the pig melting and washing apparatus is intended to promote the least handling of materials, and also good ventilation. It is not only economical, but it is humane, to arrange a plant so that men can comfortably perform the best work there is in them.

"The cupola furnaces are set 12′ from the open-hearth house, and their *débris* (drop bottoms) and slag discharge are directed away from other furnaces and operations. One hydraulic hoist raises materials with equal convenience to the charging floors of the cupola, the washing furnace, and the steel furnaces. The flow of fluid metal from the cupolas to the washing furnace, from the washing furnace to the ladle, and from the ladle to the steel furnaces, is short and direct.

"There is no lateral transference of melted metal in ladles: the washed-metal ladle stands permanently on a lift, and is once raised vertically. The system avoids the expenditure of time and labor attendant upon swinging, turning and drawing about heavy ladles on cranes, turn-tables, and cars.

"The hearths at Springfield prove large enough to convert 20-ton charges with facility. With cold pig (30 per cent.) and cold scrap, 24,000-pound heats have been made in 4 hours, and 40,000-pound heats in 8 hours. The regenerators prove abundantly large, and the burning gas plunges down upon and flows over the whole surface of the bath in such a manner as to heat it with the greatest efficiency. The importance of the removable hearth has been strikingly demonstrated; the hearth has been run out (by means of a chain from an ingot crane), its lining entirely replaced, and again run under the roof, in 17 hours from the tapping out of a charge. Meanwhile a part of the roof was renewed. It is now confidently expected that one of these furnaces will produce 100 tons of ingots per 24 hours from Krupp-washed material." — *Holley.*

See Report of A. L. Holley in Group I., "*Centennial Reports*," vol. iii., p. 37, and also report read before the Baltimore meeting of the American Institute of Mining Engineers.

Reported in . . .	* "*Iron Age*," xxiii., March 6, p. 1; March 13, p. 3.
Puddling	* Fig. 3995, p. 1817, "*Mech. Dict.*"
Process, *Heath* (1845) .	"*Iron Age*," xxiii., Feb. 13, p. 15.
Full plant	* "*Iron Age*," xxv., June 24, pp. 1, 3.
	* "*Engineering*," May 14, 1880.
	"*Scientific American Sup.*," 1121.

O'pen-hearth Steel. (*Metallurgy.*) Steel made by open-hearth process, as contradistinguished from blister, puddled, Bessemer, cast, etc.

O'pen-ing Ma-chine'. See OPENER.

The *wolf* (Fr. *loup*, the action being known as *louvetage*), or French *opening machine*, is shown in Figs. 1322, 1323, article "*Laines*," *Laboulaye's* "*Dictionnaire des Arts et Manufactures*," ii., edition 1877.

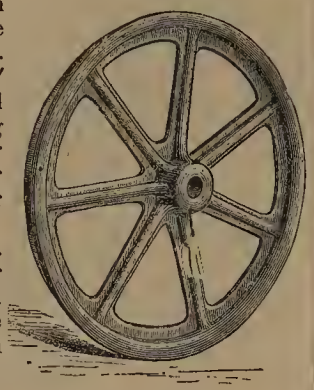
O'pen Plate Wheel. (*Railway.*) A cast-

iron single-plate wheel for street-cars, with openings cast in the plate between the ribs.

O'pen Re-turn' Bend. A U-shaped pipe-coupling having the branches open or distinct as in the letter U, and not close, or united by a fin.

O'pen Sheave. One having spokes, or mortised openings; in contradistinction to one turned solid, or with perfect web.

Fig. 1849.



Open Plate Wheel.

O'pen Sight. A sight, *through* which the object is viewed. See list under SIGHT, where many examples may be found, as also pin, fin, and globe sights which are not *open*.

Op'e-ra Flan'nel. A name given to a light flannel more highly finished than the ordinary article, piece-dyed uniformly in many fancy colors, and not pressed.

Oph-thal'mo-scope. 1. An instrument for the examination of the interior of the eye. The invention of Dr. Helmholtz; denoted on p. 1562, "*Mech. Dict.*" Dr. Knapp's auto-ophthalmoscope is Fig. 3403, p. 1563, *Ibid.*

2. An instrument for testing the form of the eye.

The metrical system of numbering the glasses has been adopted in preference to the statement by length of focus.

The dioptric unit, proposed by Prof. Donders at the congress of oculists in 1876, is a lens of 1 meter focal distance; and the following derivation: —

2 *d* (dioptric)	= 0.5 meter focal length.
1 *d*	= 1 meter focal length.
0.5 *d*	= 2 meters focal length.

The lens 2 *d* bears its relation to 1 *d* as having *double* the refracting power of the latter, and a lens of 5 *d* has one fifth the length of focus, or 5 times the refracting power of the lens 1 *d*, and so on.

The oculist's instrument for testing the focus of vision is a convenient arrangement of a series of lenses in a disk with numbers attached, so that after diagnosis the reading can be observed and the prescription for the optician readily given.

Dr. Loring's ophthalmoscope is shown in Fig. 1850. The single disk contains 16 glasses on the metric system, the plus being numbered in white, and the minus in red. The first row of numbers, or that just beneath the glass, shows the real value of the glass; the second or inner row shows the result of the combinations when the quadrant is in position. The quadrant rotates immediately over the disk and around the same center, and contains four glasses, — 5, — 16, and + 5, + 16. When it is not used the quadrant is beneath its cover. The instrument then represents a simple ophthalmoscope with 16 perforations, the series running with an interval of 1 *d*, and extending from 1 to 7 plus, and from 1 to 8 minus. This is ample for all ordinary work, as the interval of 1 *d* is as close as even an expert usually desires, and can, with a little experience, be used for even very minute discrepancies. For if in a given case the fundus is seen distinctly with 1 *d*, and a little to spare, while 2 *d* blurs the picture, we know at once that the refraction must be between the two, or 1.5 *d*. If, however, for any reason we wish to prove this conclusion, we can bring up 0.5 *d*. From this glass we get successive half-dioptric from 1 to 8 plus, and from 1 to 9 minus. If the higher numbers are desired these are obtained by combinations with those of the quadrant. These progress regularly up to 16 *d*, every dioptric being marked upon the disk; above this, up to + 23 *d*, and — 24 *d*, we have to simply add the glass which comes beneath the 16 *d*, turning always in the same direction.

Fig. 1850.

Ophthalmoscope.

The mirror shown in the drawing is the *tilting* form.

See also OPTOMETER, *infra*, and AMETROMETER, Fig. 48, p. 29 *supra*.

Op'ti-cal Glass. (*Glass.*) A flint glass of great density, owing to the quantity of lead it contains. See also STRASS.

Op'ti-cal In'stru-ments, etc. Subjects concerning optical apparatus are considered under the following heads: —

Achromatic condenser.
Achromatic right angle prism.
Adapter.
Adjusting cone.
Air pump.
Ametrometer.
Amici prism.
Amplifier.
Analyzer.
Anamorphoscope.
Aplanatic searcher.
Astrolabe.
Astronomical mirror.
Aurora tube.
Binocular body.
Binocular telescope.
Bioscope.
Bull's eye condenser.
Burette.
Camera.
Camera lucida.
Camera obscura.
Camera stand.
Cane telescope.
Capillary bottle.
Celestial indicator.
Cell.
Cell cutter.
Chromostroboscope.
Circle cutter.
Claude Lorraine.
Coddington lens.
Collecting bottle.
Compound spectacles.
Compressor.
Coneave mirror.
Condenser.
Condensing lens.
Cosmorama lens.
Current slide.
Cylindrical glass.
Dancing flame.
Dark tent.
Dark well.
Demonstration lens.
Diaphragm.
Diatom prism.
Dichroiscope.
Disk cutter.
Dissecting hook.
Dissecting knife.
Dissecting scissors.
Double image prism.
Double nose piece.
Draw tube.
Dropping tube.
Drying case.
Elbow scissors.
Engraver's glass.
Entomological pin.
Equatorial.
Equilateral prism.
Erecting glass.
Eye glass.
Eye piece.
Eye piece indicator.
Eye piece micrometer.
Eye protector.
Eye shade.
Field camera.
Field glass.
Finder.
Fishing tube.
Flat mirror.
Flower microscope.
Focussing glass.
Forceps.
Frameless spectacles.
Franklin spectacles.
Frog plate.
Glass ring.
Glass slip.
Glass stage.
Glass trough.
Glazier's diamond.
Goggles.
Goniometer.
Graphoscope.
Graphostereoscope.
Growing cell.
Hand magnifier.
Heliostat.
Heliotellus.
Heliotrope.
Illuminator.
Immersion objective.
Indicator, eye-piece.
Injecting syringe.
Insect pin.
Iris diaphragm.
Kaleidoscope.
Knife.
Lamp.
Landscape mirror.
Lens.
Lens grinding.
Lever compressor.
Lieberkuhn.
Life slide.
Light moderator
Linen prover.
Live box.
Live trap.
Lorgnon.
Louchettes.
Loupe.
Lunatellus.
Maltwood finder.
Mechanical finger.
Megascope.

Melanoscope.
Meridian circle.
Meridian iustrument.
Micrometer-microscope.
Micrometer.
Microscope.
Microscope lamp.
Microscope table.
Microtome.
Micro-spectroscope.
Mineral holder.
Mirror.
Mounting instrument.
Mounting stand.
Mural circle.
Mydriasis spectacles.
Nachet's prism.
Necessaire.
Needle, dissecting.
Needle holder.
Nichol's prism.
Nobert's plates.
Nose glass.
Nose piece.
Object glass.
Objective.
Observatory.
Opal glass slip.
Opaque disk revolver.
Opaque illuminator.
Ophthalmoscope.
Optometer.
Orrery.
Orthoscopic eye-piece.
Pankratic microscope
Parabolic illuminator.
Parabolic reflector.
Parallel compressor.
Photodrome.
Picture lens.
Pipette.
Plane table.
Planisphere.
Pocket microscope.
Polariscope.
Polarizer.
Polarizing apparatus.
Polymicroscope.
Polyzonal lens.
Prism.
Prismatic glass.
Projector.
Pulpit spectacles.
Quadrant.
Quadruple nose-piece.
Range finder.
Reading glass.
Reflector.
Repeating circle.
Resonator.
Reversible compressor.
Revolving diaphragm.
Right-angle prism.
Sciopticon.
Scissors.
Screw live box.
Section cutter.
Section knife.
Seed microscope.
Selenite.
Seleuite stage.
Shade.
Shell piece.
Side condenser.
Side reflector.
Siderostat.
Siphon slide.
Siren.
Solar camera.
Solar microscope.
Spectroscope.
Spectroscopic eye-piece.
Spectrum scale.
Spot lens.
Spring compressor.
Stage.
Stage forceps
Stage micrometer.
Stand.
Stereopticon.
Stereoscope.
Strabismus spectacles.
Student's lamp
Sun spot instrument.
Syringe.
Table.
Telemeter.
Telescope.
Telescope clamp.
Tellurian.
Temples.
Test plate.
Test tube.
Theodolite
Tightening key.
Time globe.
Tourmaline.
Transit instrument
Trial sight.
Trial spectacle frame.
Trinopticon.
Triple nose piece.
Triplet.
Tripod stand.
Trough.
Turn-table.
Valentine's knife.
Vertical illuminator.
Water lens.
White cloud illuminator.
Window mirror.
Writing diamond.

Fig. 1851.

Optometer.

Op-tom'e-ter. (*Optics.*) 1. *Badal's.* A means of ascertainiug the focal distance at which perfect vision is obtained.

It consists of a tube containing a lens, and a scale movable at the other end of a graduated tube for registering the amount of variation.

2. Risley's apparatus, Fig. 1851, is for the detectiou and measurement of astigmatism.

The instrument consists of a stand, with solid foot, on the top of which is fixed a pair of semicircles, with their concavity upward, for the reception of trial-glasses, stenopaic slit, etc. They are graduated to correspond with the Nachet trial-frames. In front of the holders is a square horizontal bar, 20″ long, graduated in fractions of an inch. Upon this bar is adjusted a freely-moving carrier, designed to bear a series of cards containing test-types, and test-figures for astigmatism, including the system of radiating lines of Dr. Green, of St. Louis. The whole set is intended for use at 12″ instead of 20″. Some of the tests are cut in thin brass disks, and are to be used over an illuminated backgrouud, which is furnished by a plate of ground glass. A plate fitting the carrier has a central opening designed to receive these disks, and to permit their free rotation over a graduated scale corresponding to that upon the holders. One of this series of test-objects is a wire *optometer*, consisting of a brass rim, with two gronps, each containing five wires, stretched one millimeter apart, the two groups crossing the center at right angles.

There is also an adjustable *perimeter*, which can be removed when not in use.

See also Ophthalmoscope, Fig. 1850 p. 646; Ametrometer, Fig. 48, p. 29; Astigmatism Apparatus, Fig. 124, p. 53, *supra*.

O'pus Con-su'tum. Cut cloth-work or *appliqué*.

O'ral In'stru-ments. (*Surgical.*) See Ear Instruments.

Or-ches'tri-on. (*Music.*) An instrument constructed on the principle of an organ, except that the tubes are caused to *speak* by means of a mechanical arrangement similar to that used in a *musical box*, instead of being operated by means of a key-board or manual. They frequently contain, in addition to the reed stops, metal pipes, bells, drums, etc., etc.; in fact, anything that will give forth a sound when you strike or blow it; but no strings.

See p. 108, Class XVI., vol. ii., Official Catalogue British Exhibition, 1862.

Ore Car. (*Railway.*) A small, narrow-gage car, with four wheels, used on tracks in mines for transporting minerals to daylight.

Ore Dry'er. A machine in which a vibrating screen furnishes the sand and metallic particles to the hopper, from which it is discharged in a regular stream, under the influence of the rotary agitators, into the drying cylinder below, that is kept heated by a furnace in the basement of the machine.

As the sand dries and becomes less cohesive, the rotary heated cylinder discharges it through its spout into a receptacle beneath.

Ore Ma-chin'er-y. See the following references: —

Breaker, *Blake* . . . * *Laboulaye's* "*Dict*," ii. (ed. 1877), Art "*Métallurgie*," Fig. 1770.
Tin ore . . . . * *Ibid.*, Fig. 1771.
Lead ore . . . . . * *Ibid.*, Fig. 1772.
Classifier . . . . . * "*Engineering*," xxii. 329.
* "*Min. & Sc. Press*," xxxiv. 73.
Wengler & Lowe . . * "*Eng. & Min. Jour.*," xxii. 139.
Concentrating-table . . * "*Min. & Sc. Press*," xxxiv. 161.
Concentration, *Krom* . * "*Eng. & Min. Jour*," xxii. 284.
Crusher, *Alden* . . . "*Sc. American*," xxxviii. 54.
* "*Eng. & Min. Jour.*," xxiv. 419.
* "*Am. R. R. Jour.*," li 287.
* "*Man. & Builder*," x. 241.
Baugh . . . . . * "*Eng. & Min. Jour.*," xxii. 296.
Sectional crush., *Bloke* . * "*Scientific American*," xli. 306.
Blake . . . . . * "*Eng. & Min. Jour.*," xxii. 311; xxviii. 393.
Brown . . . . . * "*Scientific American*," xl. 194.
* "*Eng. & Min. Jour.*," xxvi. 184.
Phelps . . . . . * "*Eng. & Min. Jour.*," xxviii. 53.
Dressing app., *Allouez*, Lake Superior . . . * "*Eng. & Min. Jour*," xxiii. 294.
Dressing works, *Clausthal* * "*Eng. & Min. Jour.*," xxviii. 134.
* "*Engineering*," xxi. 35, 64, 102, 106, 167, 209, 249, 298, 303.

Dressing: "Report on Mechanical Dressing of Minerals," by *E. F. Althans*; "*Centennial Exhibition Reports*," Group I., vol. iii., p. 207.

Von Sparre Laboratory ore dresser . . . * p 228
Blake's Ore crusher . . . . . * p. 238
Marsden's Ore crusher . . . . . * p. 239
Krom's Roller crusher . . . . . * p. 242
Coxe Bros. & Co.'s Anthracite breaker . . * p. 246
Dingey, Horizontal mill . . . . . * p. 248
Althan's Stamp cams . . . . . * p. 251
Ball's Steam stamp . . . . . * p. 258
Ball's Stamp mill . . . . . * p. 261

Sievers & Co.	Sorting drum	* p. 269
	Coal dressers	p. 273
	Concentrators	p 279
Blei-scharley, Silesia	Fine grain jig	* p. 288
Kasalovsky's	Double jig	* p. 289
Lake Superior,	Copper jig	* p. 290
Evrard's	Decanteur	* p. 297
Evrard's	Hydraulic classificator	* p. 299
Krom's	Dry ore conceutrator	* p. 303
	Settling apparatus	p. 307
	Sluice tables	p. 306
	Electro magnetic concentrators	p. 313
Evrard's	Rotary picker and sorter	p. 322

Feeder, *Hendy*		* "*Min. & Sc. Press*," xxxiv. 271.
Tulloch		* "*Min. & Sc. Press*," xxxiv. 319.
Stevenson		"*Min. & Sc. Press*," xxx. 323.
Tulloch		* "*Min. & Sc. Press*," xxxv. 401.
Furnace, revol., *Bruckner*		* "*Iron Age*," xvii., Jan. 13, p. 1.
Eames		* "*Scientific American Sup.*," 714.
Mill, *Paul*		"*Scientific American Sup.*," 596.
Process, ammonia.		
Clarke & Smith, Br.		"*Van Nostrand's Mag.*," xv. 108.
Holliway		"*Iron Age*," xxiv., July 24, p. 3.
Monnier		* "*Scientific American Sup.*," 771.
Stewart		"*Min. & Sc. Press*," xxxiv. 266.
Davis		* "*Min. & Sc. Press*," xxxviii. 137.
Roasting furnace, *Fryer*		* "*Scientific American Sup.*," 172.
Shaft, *Ramage*		* "*Iron Age*," xxii., Nov. 28, p. 5.
Separator, magnetic.		
Babcock & Ewell		* "*Scientific American*," xliii. 291.
Magnetic, *Edison*		"*Scientific American*," xlii. 388.
		* "*Scientific American*," xliii. 36.
		* "*Engineer*," l 6, 91.
Sifter		* *Laboulaye's* "*Dict.*," ii., ed. 1877.
Lalande		* *Ibid.*, Fig. 1776, "*Métallurgie*," Fig. 1773.
Stamp, *Ball*		* "*Iron Age*," xxi., May 9, p. 1.
Direct act., pneumatic		
Sholl, Br.		* "*Engineer*," xliii. 95.
Washing mach., *Curson*		
Iron Works, Fr.		* "*Engineering*," xxvi. 80.
		* *Laboulaye's* "*Dict.*," ii. ed. 1877, Art. "*Métallurgie*," Figs. 1765–1769.
French		* "*Scientific American Sup.*," 2227.
Taylor		* "*Scientific American Sup.*," 1322.
Works, *Clausthal*		* "*Eng. & Minnig Jour.*," xxi. 247, 295, 303, 319, 345, 415, 439.

Or'gan. See the following references : —

History of the organ in report of *H. K. Oliver* on group XXV. in vol. vii., "*Centennial Exhibition Reports*," p. 35.
Parlor organs, *Ibid.*, p. 45.

Blower	* Figs. 3426, 3427, p. 1576, "*Mech. Dict.*"
Backus	* Fig. 7120, p. 2743, *Ibid.*
	* Hydr. Blower, Fig. 1401, p. 475, *supra.*
Electricity, applied to	* "*Telegraphic Journal*," iv. 84.
	* "*Manuf. & Builder*," viii. 64.
	"*Scientific American Sup.*," 724.
Electric & pneum. appli.	* "*Scientific Amer.*," xxxiv. 117.
Cincinnati Music Hall compared with others	"*Sc. American*," xxxviii. 324.
Pipes	* *Laboulaye's* "*Dict.*," "*Orgues*," ed. 1877.
Reeds, manufacture of	"*Scientific American*," xl. 110
Garden City Cathedral	"*Scientific American*," xli. 385.

Or'gan, Au'to-mat'ic. See AUTOPHONE, p. 57, *supra.*

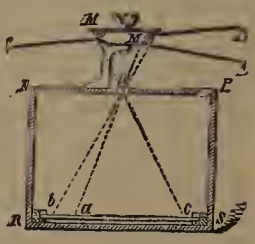
Or'o-graph. (*ὄρος*, a mountain.) An instrument for mapping undulating or mountainous surfaces.

As constructed by M. Schrader, the instrument consists of a circular paper-covered plate with central vertical axis carrying a sleeve which can turn round freely. On the top of the sleeve is a telescope on a frame, the movements of which in altitude are communicated to a pencil, and transformed by gearing into to-and-fro movements. If the telescope revolves in azimuth, the style describes a circle on the plate; a motion in azimuth compounded with one in altitude, gives an oblique line, an outward or inward curve; the trace produced being farther from or nearer to the central axis, as the movement in altitude increases or diminishes. A spirit-level is fixed to the telescope, and graduated scales give the value in height of any point on the tracing.

Or'o-he'li-o-graph. An instrument invented by M. Noë, and described in a memoir to the Photographic Society of France.

It consists of a camera, the sensitive plate forming the inner horizontal floor, and the lens looking up perpendicularly to the sky. Over the lens is placed a silvered mirror, half globe-shaped, completely circular on its plan and parabolic through its vertical section. The result is that an image of all surrounding objects reflected from this half-ball-shaped mirror is received by the lens, and transmitted thereby to the sensitive plate underneath, with its surface forming a right angle with the axis of the lens and circular mirror. By this means a circular panoramic view of the horizon is obtained, as seen from the station the oroheliograph occupies.

Fig. 1852.



Oroheliograph.

This instrument is described in "*Scientific American*," xxxviii., 40, * 116. See also PHOTOGRAPHOMETER, *infra.*

Or'tho-pe'dic Ap-pli'an-ces. Apparatus for talipes, eversion of the feet, etc.

See Report by *Dr. J. H. Thompson*, of Group XXIV., * in vol ii., "*Centennial Exhibition Reports.*" *Darrach's* rawhide appliances, *.

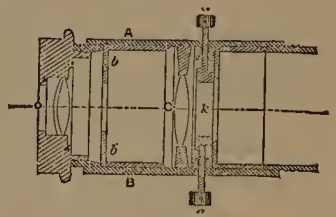
Dr. Stillman's "*Contributions to Orthopædic Surgery*," * "*Medical Record*," August 30, 1879.

See also CLUB-FOOT APPLIANCES AND SPLINTS, pp. 203, 204; CURVATURE APPARATUS, p. 236, *supra.*

Or'tho-scopic Eye'piece. A combination of lenses used in an eye-piece, giving a very large field of view.

Kellner's orthoscopic eye-piece is achromatic, and has the advantage of an actually flat field and a straight, flat image of any object, correct in perspective, distinct in its whole extent. It consists of three lenses, the bi-convex collective lens *C*, the flatter curve of which is toward the object-glass, and the achromatic lens *O*, which is composed of two lenses, similar to the achromatic object glass. *b b* is a diaphragm.

Fig. 1853.



Orthoscopic Eye-piece.

O-ru'go. From Latin *Aurūgo*, the jaundice, referring to the yellow color induced by oxidation. The peculiar oxidation seen on ancient bronzes, and which gives character to the antique medals and statuary in that alloy.

See PATINA.

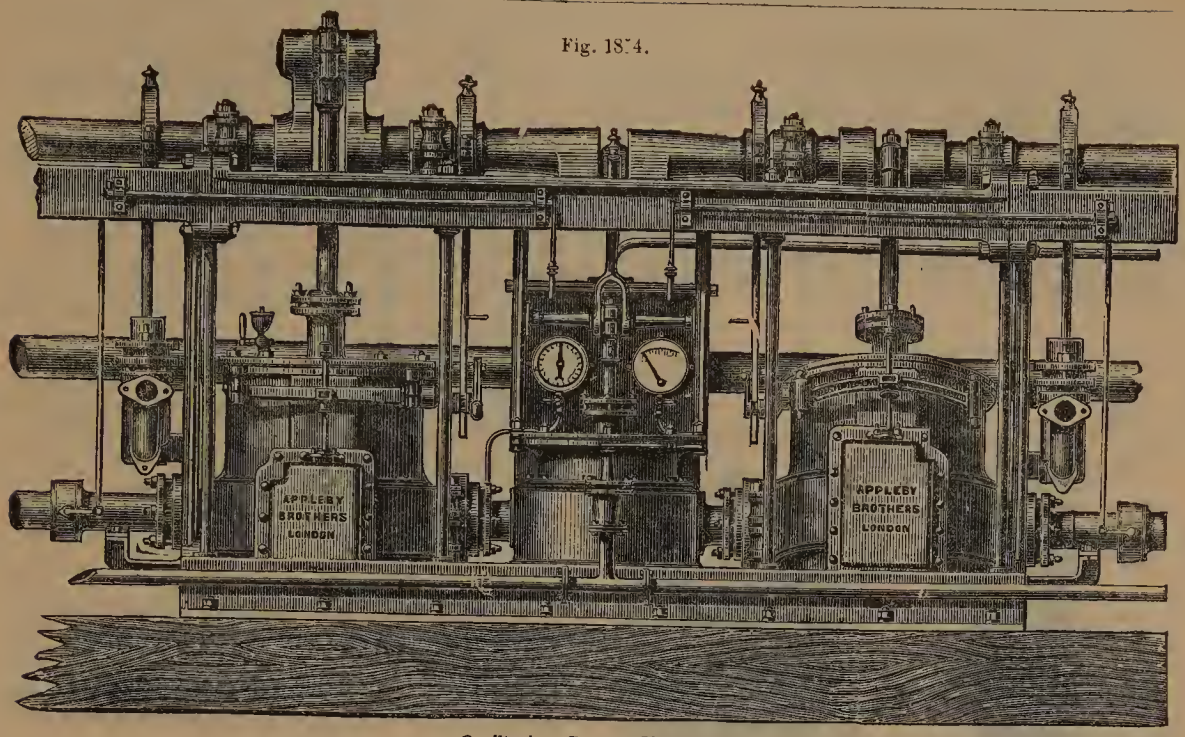
Os'cil-la'ting En'gine. Engines with oscillating cylinders are shown in Figs. 3430–3433, pp. 1578, 1579, "*Mech. Dict.*"; Screw Propeller Engines, * p. 2073, *Ibid.* See also MARINE ENGINE, *supra.*

The type of paddle engine, shown in Figs. 1854, 1855, has been more used in Great Britain than any other on account of the large power which can be provided in a very limited space; the piston rods working direct on to the crank pins, there is little loss by friction except that due to the friction of the trunnions. The steam enters the cylinders through the outer trunnions, and, when it has done its work, passes through the inner trunnions to the condenser. The air-pump is driven from a crank central between the two cylinders, and the two feed-pumps are driven by eccentrics on the paddle shaft. The bearings for the paddle shaft are carried on a strong entablature, which is supported on wrought iron stays or columns from a massive base plate.

Such engines are employed on the English channel and river steamers, and the form of the framing is such that, while light, it has strength to resist the strain caused by the work being suddenly thrown on one paddle, while the next moment the deep immersion is sufficient to greatly retard the normal speed of the engine.

Oscillating cylinder eng.,		
"Lord of the Isles"		* "*Scientific American Sup.*," 1458.
Penn		*Laboulaye's* "*Dict.*," "*Bateau à Vapeau*," IV., Figs. 3415, 3416.
Oscillating steam engine.		
Roberts		* "*Man. & Builder*," x. 145.
For light draft steamers.		
Wilson, Br.		* "*Engineering*," xxiii 341.
Wheel, feathering.		
Williams		* "*Scientific American*," xxxvi. 374.

Fig. 1854.



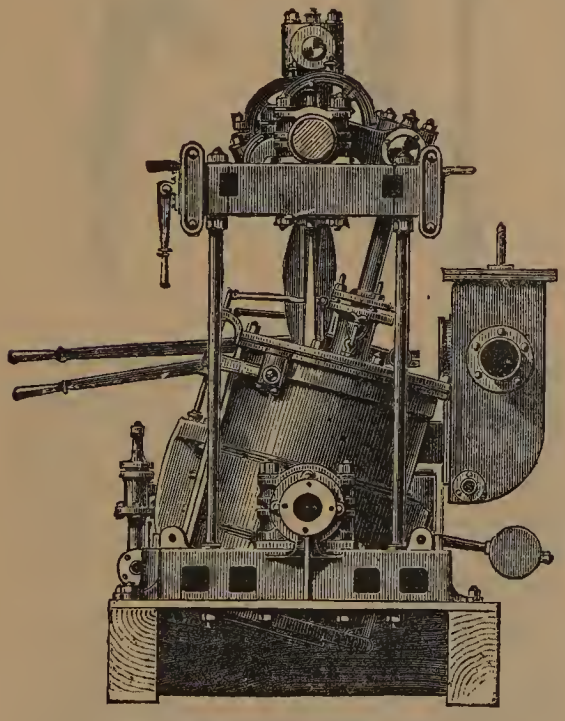
Oscillating Paddle Engine.

Os'cil-la'tor. A machine, the principal or an important functional portion of which vibrates in a curved track; *e. g.*, the oscillating-cylinder steam-engine, the oscillating-shuttle sewing machine.

Os'cil-lom'e-ter. An instrument for measuring the angle through which a ship rolls at sea.

Clark . . . . . * "*Engineering*," xxvii. 406.

Fig 1855



Oscillating Paddle Engine. (*Side Elevation.*)

Os'mo-gène. An osmotic apparatus of M. Dubrunfaut, adapted to the refining or fabrication of sugar. Described in *Laboulaye's "Dictionnaire des Arts et Manufactures,"* tome iii., article "*Sucre*," Figs. 78, 79, "*Osmose.*"

Os'te-o-phor. (*Surgical.*) A powerful bone forceps with long serrated jaws. *Hamilton.* Fig. 53 *c*, p. 12, Part I., *Tiemann's "Armam. Chirurg."*

Os'te-ot'o-my In'stru-ments. (*Surgical.*) See Bone Instruments, p. 119, *supra.*

Os'te-o-trite. (*Surgical.*) A conoidal-shaped bone-drill. *Marshall.* Fig. 78 *c*, p. 22, Part I., *Tiemann's "Armamentarium Chirurgicum."*

Os U'te-ri Di-la'tor. See Cervix Uteri Dilator, "*Mech. Dict.*" *et supra.*

O-the'o-scope. A form of radiometer devised by Mr. Crookes, which revolves, even though destitute of a glass envelope.

"The first form of otheoscope described by M. Crookes consists of a four-armed fly, each carrying a vane of thin clear mica. At one side of the glass bulb which incloses the apparatus there is a vertical plate of mica blackened on one face, and so placed that each vane closely approaches it as the mill rotates. If light be allowed to fall only upon the clear vanes, no motion is produced; but if the light shine upon the black plate the vanes instantly begin to rotate, as though repelled by a molecular wind blowing from this surface. The movement is therefore produced by pressure generated on a fixed part of the apparatus, by which the movable portion is propelled. As this driving-surface is stationary, it is not restricted in weight, size, or shape; and hence the modifications of which the otheoscope admits are well-nigh endless."—"*Chemical News*," May 4, 1877.

Out'crop. (*Mining.*) That portion of a vein appearing at the surface.

Out'er-hung Brake. (*Railway.*) One in which the brake shoes and beams are attached outside of the wheels.

Out'rig-ger Hoist. A hoisting apparatus rigged out from an outer wall; as distinct from the hatchway hoist.—*"*Scientific Amer.*," xxxviii. 223.

Out'side Mold'ing Ma-chine'. That form of wood-planing machines in which the cutter is on an overhung spindle; in contradistinction to the *inside* molding machines, in which the cutter is between the bearings of the spindle. See Fig. 3198, p. 1467, "*Mech. Dict.*"

Out'sole Tack'ing Ma-chine'. One which drives a headed nail with a clinching point, which buries itself in the insole, to secure the outsole to the insole for future sewing or pegging.

PLATE XXXIII. FRENCH OYSTER IMPLEMENTS. *See page* 651.

plied to the hoisting reel, and the cage, with its load, is instantly stopped.

See DETACHING HOOK, Fig. 802, p. 253, *supra*.

For mine cages . "*Min. & Sc. Press*," xxxvii. 369; xxxvi., 325.
"*Iron Age*," xxii., August 1, p. 19.

Laboulaye's "*Dictionnaire des Arts et Manufactures*," iv., ed. 1877, artiele "*Parachute*," treating of safety apparatus for cages in mines, etc.

Ox'i-dized Sil'ver. "The color of so-called oxidized silver depends on sulphurization. The silver goods are dipped into a boiling-hot solution of calcium sulphide or hyposulphite of soda, or into ammonium sulphide, until they have taken the proper color. 'Old silver' is a coloration produced by laying on a mixture of graphite and oil of turpentine, or some fatty matter, and cleaning off with blotting paper until no more color comes away. Copper acquires a handsome look if treated in the same manner. If it is desired to varnish oxidized silver, take 18 parts alcohol, 3 red arsenic, and 1 castor oil, and a non-transparent varnish can be made, which may be diluted with its own volume of alcohol, if a particularly thin coating is wished." — "*Engineering and Mining Journal*."

Oys'ter Cul'ture.

LIST OF UNITED STATES PATENTS.

125,470	Oyster basket of galvanized metal strips.
127,903	Oyster nursery.
130,631	Hoisting bueket, bottom of angle iron and bars.
149,921	Sunken net to keep off star-fish.
212,389	Tank for fattening oysters; may be lowered into the water.
217,558	Oyster float to keep oysters submerged.
221,326	Oyster feeder; two tanks with inclined bottoms.

Oys'ter Dredge.

LIST OF UNITED STATES PATENTS.

25,680	Dredge rope runs over a pulley; landed over roller. Reissued February 4, 1868.
27,213	Rake ruus on sled runners.
35,324	Guards or fenders on dredge head.
38,436	Conieal wheels to roller on gunwale.
45,904	Fenders rods to aid getting dredge over roller.
55,223	Flange on roller to aid in getting dredge aboard.
59,812	Davit on gunwale to raise dredge.
65,442	Screw roller on gunwalc.
74,857	Aids in getting dredge aboard.
78,509	Construetion of dredge head.
81,304	Adjustable rake, and elevis.
85,936	Guides for dredge rope to roller.
89,323	Guide bars on dredge head.
97,420	Wire basket hehind dredge rake.
109,104	Wiuding apparatus for dredge rope.
120,463	Adjustable rake. Float to keep it vertical in sinking.
121,227	Open-arched cage to dredge.
121,249	Windlass.
122,423	Construetion of dredge.
125,964	Automatie adjustment of rake.
132,668	Automatic adjustment of rake.
138,164	Construction of rake.
141,439	Bottom opens to discharge oysters.
144,169	A dredging scoop, with angular blade and prongs.
178,493	Windlass.
197,341	Windlass.
217,031	Hoisting drum and shaft.
220,827	Dredge winder.

Steam dredge, *Graves*. . "*Scientific American Sup.*," 3947.

Oys'ter Im'ple-ments. These are of various kinds, and the practices of countries and districts differ materially. See under the heads: OYSTER TONGS, RAKES, etc.

Plate XXXIII. is a collection of the implements used in France, in the parks of St. Brieuc, Arcachon, and the Island of Ré on the coast of Bretagne: —

1. *a*, Wooden rake for cleaning oyster park.
   b, Rake for moving oysters.
   c, Rake for cleaning oyster parks.
2. Wooden rake for removing oysters from the parks.
3. *a*, Shovel for lifting oysters from the mud.
   b, Shovel for use in the parks.
   c, Wooden shovel for washing collectors after removal from the parks.
   d, Wooden rake for cleaning parks and basins.
   e, Iron shovel for lifting oysters from the mud.
4. Fork for hunting and destroying eels.
5. Shovel for throwing water on oysters after they have been takeu from the beds.
6. Wooden rake for removing oysters from the parks.
7. Two-pronged hook for raising oyster basket.
8. Shovel to seleet oysters in boxes, taking only the large ones.
9. Knives for breaking up bunches of grown oysters.
10. Sifter for separating different sizes of oysters.
11. Trap for taking crabs.
12. Shovel for raking oyster beds.
13. Double hook for raising bunches of oysters.
14. Knife for breaking up bunches of growu oysters.
15. Tool for boring holes in tiles.
16. Tool for boring holes in tiles.
17. Knife for breaking up bunches of grown oysters.
18. Lock for letting water in and out of the parks.
19. Knife for breaking up bunches of grown oysters.
20. Caisson for raising oysters.
21. Caisson for breaking oysters after being taken from the tiles.
22. Iron rake for raking oyster beds.
23. Drag net with rake. (Prohibited in France.)
24. Galvanized wire basket for washing oysters.
25. Drag-net, used only under surveillance of the maritime guard.
26. Stationary nippers for separating the oyster from the tiles by breaking the tiles.
27. Hand-barrow for carrying oysters.
28. Crab-trap made of wood and galvanized wire.
29. Machine for separating oysters of different sizes.
30. Rotary rake for removing clay and slime from oyster beds.
31. Crab or lobster trap made of galvanized wire.
32. Sifter for separating oysters.
33. Machine for separating oysters aud scraping them from the slates.

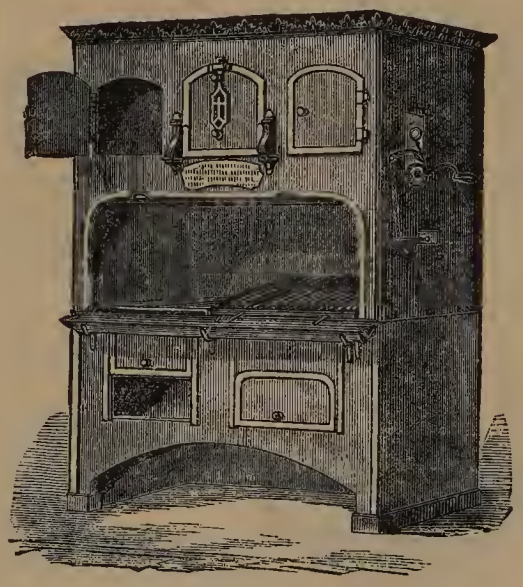
Oys'ter Rakes and Tongs.

LIST OF UNITED STATES PATENTS.

19,516	Grapnel jaws, with locking catch.
44,634	Barrel used as a drum in hoisting rakes.
58,426	Pair of rakes, with handles and lever cateh.
75 550	Pair of rakes, with lazy tongs.
76,697	Hinged rake-heads.
105,495	Grapple tongs.
107,740	Grapple tongs.
135,167	Construetion of rake.
201,559	Construction of tongs.

Oys'ter Range. A cooking arrangement, with the various appurtenances for stewing, broil-

Fig. 1858.



Oyster and Chop-house Range.

ing, roasting, frying, baking of oysters. To cite the possibilities would be to copy a page of a possible bill of fare.

Oys'ter Tongs. A pair of hinged claws which are approached to gather the oysters, and then form a tray in which they are contained while being lifted on board.

Fig. 1859.

Oyster Tongs.

O'zo-ke'rite. A fossil gum, found in Africa.

Cire fossil, Weil . "*Technologiste*," xxxviii. 308.
Refined . . . . "*Technologiste*," xlii. 430.

O'zone Ap'pa-ra'tus. In M. Bertholet's apparatus for the thermic formation of ozone, the gas is produced by means of the silent electric discharge.

It consists of a glass tube to which are connected two smaller tubes. A fourth tube is placed in the large tube. The apparatus is filled with a conducting liquid, water acidulated with sulphuric acid, and inserted in a test tube filled with the same. The electrodes communicate with the liquid in the interior tube, and with that in the test glass. The silent discharge takes place in the annular space between the tubes and acts on the oxygen which enters at one of the smaller tubes and escapes at the other. The gas is thus transformed into ozone through the influence of the current.

Ozone Machine, *Bartlett* * "*Scientific American*," xxxv. 83.
Apparatus . . . . . * "*Scientific American Sup.*," 727.
Leeds . . . . . * "*Scientific American Sup.*," 2453.
Ozonizer . . . . . * "*Man. & Builder*," xii. 133.
Generator, *Leeds* . . . "*Scientific American*," xl. 242.
Ozonoscope . . . . . "*Scientific American Sup.*," 2454.

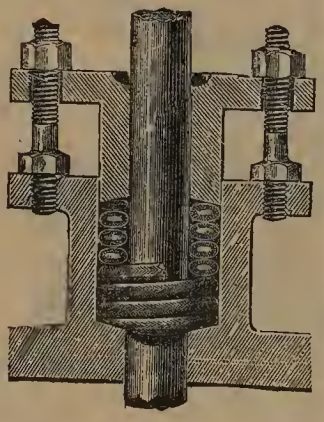
P.

Pa-chym'e-ter. A Viennese instrument which determines the thickness of paper to the 1–1000th of an inch. The micrometer caliper (which see) has much more delicate adjustment.

Pack'ing. A stuffing around a part to prevent leakage of a fluid.

Various materials and applications are given under PACKING, p. 1590; and PISTON PACKING (45 citations), pp. 1717, 1718, "*Mech. Dict.*"

Fig. 1860.



Steam Packing.

The packing shown is that of Ottenson, Hamburg. It is a wick-twisted hose stuffed with mineral and animal grease, and wound around the piston rod in a continuous coil. The gland being screwed down upon the packing expresses sufficient of the lubricant.

Cf. Gun-metal, *Faull* . * "*Engineer*," xlix. 439.
Metallic . . . . . "*Scientific American Sup.*," 2739.
Jackson . . . . . * "*Scientific American Sup.*," 1827.
Katzenstein . . . . * "*Iron Age*," xxv., April 29, p. 7.
Steam, *Phillips* . . . * "*Scientific American*," xlii. 150.
Hemp and Soapstone . * "*Iron Age*," xx., Nov. 29, p. 9.
Wire cloth & caoutchouc.
Beardmore . . . . * "*Iron Age*," xxv., April 29, p. 9.

Pack'ing Ex-pand'er. A spring to spread the packing of a piston or valve against the surface upon which it traverses. See numerous examples in Fig. 3759, p. 1716, "*Mech. Dict.*"

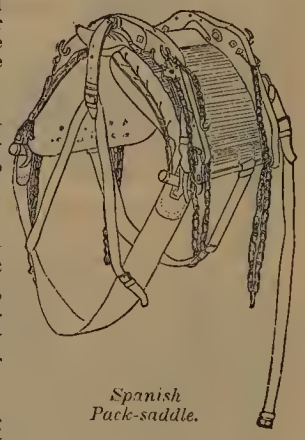
Pack'ing Gland. An annular piece, the cover of a stuffing box, which is screwed or otherwise forced into the stuffing box to expand the packing against the piston. See PACKING, *supra*.

Pack'ing Leath'er. A leathern ring on a piston or plunger, traversing against the cylinder or barrel to make a tight joint therewith.

Pack Sad'dle. The Spanish military pack saddle is shown in Fig. 1861.

The saddle has an adjustment of the sides relatively so as to fit the width of shoulders of the pack mule. The pommel and cantle afford points of attachment for the breast, buttock, and belly bands, and also for the chains by which the load is fastened on to the saddle. The body is sheet iron, with a covering of leather sewed with wire. The lining is of thicknesses of hair felt secured by clasps to the saddle and capable of being removed and opened so as to take out or add thicknesses to adjust the saddle to the shape of the mule's back.

Fig. 1861.



Spanish Pack-saddle.

Pad Brack'et. A stable-wall bracket having a shape adapted to receive the saddle which rests thereon.

Pad'lock. Several forms of padlocks are shown on page 1575, "*Mech. Dict.*," and others may be found by titles in the list under LOCK, p. 1342, *Ibid.*

The *Miller* self-fastening lock, which operates by thrusting in the tang of the hasp, is shown in Fig. 1862. In the upper figure the outer plate is removed to exhibit the mechanism. *A* is the dog, which is so pivoted as to fit into a recess of the hasp *B*, when the latter is pushed down. The end of the lower arm of the dog is formed with an angular projection *C*, which, engaging against a properly shaped shoulder at the bottom of the recess, holds the hasp in the position mentioned in opposition to the upward tending force of one arm of the spring *D*. At *E* are the tumblers, either six or seven in number, according to the size of lock, all of which are pivoted on a single pin, and each provided with a bent wire spring, as shown. The upper portion *F* of one of these springs, instead of resting, as do the others, against the projecting part in the shell, is brought forward and under the straight arm of the dog, so as to force the lower arm of the latter against the tumblers, and causes the projection *C* to enter notches in the tumblers, when the same are brought into proper position.

Fig. 1862.

Self-locking Padlock.

Owing to the angle of the

notches in the tumblers, and to the dog being in a solid piece, it is only when all the notches coincide that the projection can enter them. By means of varying the positions of the notches on the tumblers, a special key is required to operate each, in order to render all the notches coincident. The key having peculiarly formed projections and recesses at its extremity, acts on all the tumblers simultaneously, and lifts each the exact distance required.

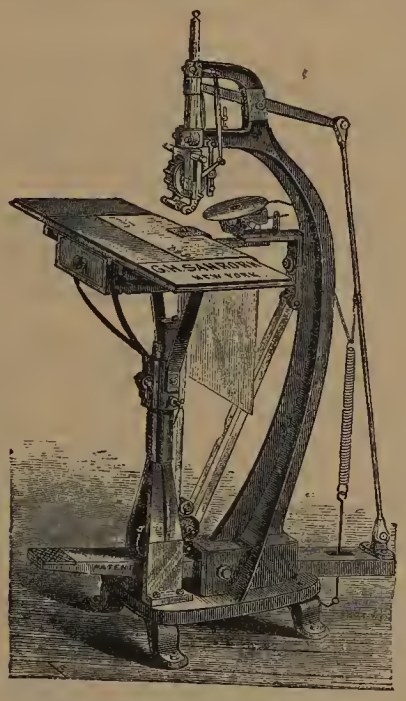
The key is merely pushed in the proper aperture, freeing the dog as above described, and allowing the hasp to be acted upon by the spring *D*, and so lifted upward into the position indicated by the dotted lines, in Fig. 1862. Motion in this direction is then limited by the catch *H*.

Lock, *Miller*. . . . * "*Iron Age*," xxi., April 4, p. 1.

Pa'ging and Num'ber-ing Ma-chine'. The principle of the change of numbers in paging machines is described under that head, p. 1596, "*Mech. Dict.*"

Suteliff's paging and numbering machine is shown in Fig. 1863. It is adapted for paging blank books, for numbering bonds, checks, drafts, policies, tickets, etc.

Fig. 1863.



Paging and Numbering Machine.

The cut represents the machine ready for numbering, with the table up, and the smut-band removed. For paging books, as large figures are used, it is necessary to change the head, and replace the smut-band to prevent smutting the pages. This machine is compact, has two inking rollers, both of which ink the figures, an adjustable gage, and an endless smut-band. With a four-disk head it will number or page to 10,000; with six disks will number to 1,000,000.

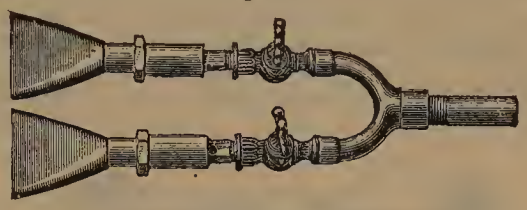
Pail and Tub Ma-chin'er-y. See Fig. 3484, p. 1596, "*Mech. Dict.*"

In Whitney's pail and tub machinery the wood is sawn into planks the breadth of the staves, then cut into pieces of the proper length; these are again sliced into staves by a stout cylindrical saw with the teeth formed upon its extremity; the staves are now baked in an oven, then have the edges planed by a suitable machine to the required form, the pail is set up with a temporary hoop and slipped upon a conical chuck, there held by an end-washer, plate, and bolt, and the hoop removed. A slide-rest tool is then passed along the exterior surface, the temporary hoop is again applied, and then pushed into a box chuck, another slide-rest tool is passed down the interior and finishes at one move. When at the bottom, the workman with the left hand in an instant moves another chisel to form the groove for receiving the chine of the pail-bottom and chamfers the upper edge. The boards for the bottom are planed on both sides in an ordinary machine, then sawn into squares: the squares are gripped between revolving plates and cut to the proper diameter by a parting tool, when a second tool bevels the edge to fit the pail.

Paint Burn'er. An instrument for softening paint by heat or gas, in order that it may be removed. Fig. 3188, p. 1597, "*Mech. Dict.*"

Reed's atmospheric paint burner, for softening paint with gas, is shown in Fig. 1864. The two burners are flattened out so as to present a wide sheet of flame.

Fig. 1864.



Paint Burner.

Acid proof paint . . "*Scientific American*," xxxv. 278.
Copper paint . . . . "*Scientific American*," xxxv. 18.
Paint in construction, *Grimshaw* . . . . "*Scientific American Sup.*," 1993.
Cleaning oil paintings. "*Scientific American Sup.*," 1994.

Paint'ing Ma-chine'. A machine for painting of laths or strips of wood, or iron, evenly and thoroughly on both sides and on the edges. — *Roberts*, Br.

There are two feed rollers, the lower of which is grooved spirally, and has at each end a paddle-wheel with floats so arranged as to dip into a tank of thin paint, and, carrying up the liquid, throw it on the rollers and on the strips which may be fed between them. The strip or lath is thus washed with paint on both sides, and it next passes between two long brushes which distribute the color evenly, and remove and return to the tank below any excess of paint.

The speed of the small machine, which takes in a lath 3″ wide and ¼″ thick, is estimated at 6,000 running feet, say 600 laths per hour, on both sides and both edges; requiring the attention of one man and two boys. The rollers and the brushes have a vertical adjustment by means of screws.

Paint Mix'er. A can with shaft and paddles, resembling an upright churn. Used to mix paint with the necessary oil, turpentine, varnish, or what not. The shaft is driven by hand-crank and gearing, and the outlet is by faucet with a gate.

Pa-lam'poor. (*Fabric.*) A bed cover. A highly decorated printed cotton goods of India. See PALLAMPOOR, p. 1599, "*Mech. Dict.*" Also p. 427, *Ibid.*

Pal'a-tor'rha-phy In'stru-ments. (*Surgical.*) For sewing up a cleft palate, synonymous with staphylorraphy. See Fig. 5563, p. 2309, "*Mech. Dict.*"

Pa'le-o-phone'. A writing telephone. *Cross.* "*Technologiste*," xl. 48.

Pa'li-er Glis'sant. A bearing where the journal runs on a film of lubricant or water.

See Fig. 3496, p. 1599, "*Mech. Dict.*" See also HYDRAULIC PIVOT; WATER BEARING, *Ibid.*; and JOURNAL BEARING, Fig. 1499, p. 516, *supra.*

Palier graisseur, *Béthouart et al.* . . . . . * "*Technologiste*," xl. 337.
Palier graisseur, *Delerm* * "*Technologiste*," xxxix. 278.
Pivot hydraulique, *Girard* . . . . . * "*Technologiste*," xxxix. 73.

Pa-lis'sy Ware. (*Ceramics.*) A faïence with stanniferous glaze and raised decorations made by Bernard Palissy, of Saintes, France, about 1555.

His work was principally representations of aquatic objects: fish, shells, lizards, etc., in relief.

Fig. 1865.

Palm.

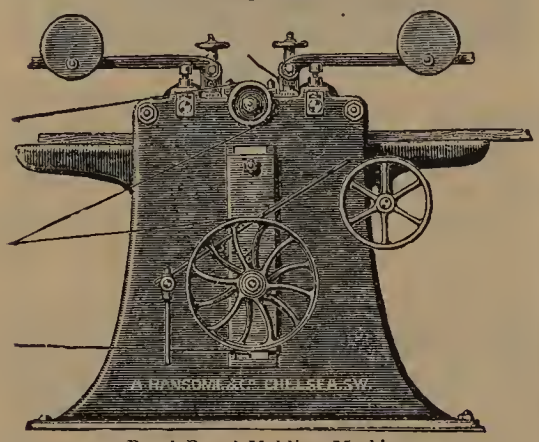
Palm. The sailor's thimble: made of leather, with a hole for the thumb and an abutment over the palm of the hand for the needle.

Pan'el Pla'ner. 1. A planing machine for working on thin stuff for panels, dressing the surface, and feathering the edges to enter the grooves in the stiles.

2. A machine for rabbeting down the edges of panels in order to leave a raised central portion. A PANEL RAISER, Fig. 3502, p. 1602, "*Mech. Dict.*"

The boards are fed through the machine by two pairs of rollers, all of which are driven so as not, by slipping, to mark the surface. The cutters are secured to a wrought-iron adze block, and the pressure bars hold the board firmly on either side of the cutter head.

Fig. 1866.



Panel Board Molding Machine.

S. A. Woods & Co. . . * "*Manuf. & Builder*," viii. 193.
Rowley & Hermance . * "*Scientific American*," xliii. 164.

See also MOLDING MACHINE, Figs. 3200, 3201, p. 1468, "*Mech. Dict.*"; SHAPER, Fig. 4916, p. 2133, *Ibid.*

Pan'krat-ic Mi'cro-scope. The microscope of Oberhauser & Ploessl. It has a sliding tube containing the eye-piece, by which its distance from the object glass may be changed, and various degrees of enlargement of the image obtained without change of glasses.

* "*Manufacturer & Builder*" . . . . . xi. 85.

Pan'ning Ma-chine'. A cracker or biscuit machine which rolls and dusts the dough, cuts into crackers, biscuits, cakes, or snaps, separates the same from the scraps, and places the work on pans ready for the oven. See CRACKER MACHINE, Fig. 715, p. 228, *supra.*

Pan-tel'e-graph. One for reproducing at the receiving end a message in the handwriting of the sender.

See FAC-SIMILE TELEGRAPH, p. 324, *supra;* AUTOGRAPHIC TELEGRAPH, p. 56, *supra;* ELECTRIC WRITING APPARATUS, * p. 304, *supra*, and references *passim.*

Sawyer . . . . . "*Iron Age*," xviii., July 20, p. 3.
* "*Scientific American Sup.*," 302.
d'Arlincourt . . . . "*Jour. Soc. Tel. Eng.*," vii. 15.
* "*Teleg. Jour.*," vi. 495; vii. 28.
Caselli . . . . . "*Mech. Dict.*," p. 191.
Meyer . . . . . * *Supra*, p. 56.
Cowper . . . . . * *Supra*, p. 304.
Bonelli . . . . . "*Mech. Dict.*," p. 784.

Pan-tel'e-phone. A microphonic transmitter, so named by its inventor, *Prof. Leon de Locht*, Liège.

It is sensitive to sonorous vibrations emanating at a great distance. It is capable of transmitting words spoken at 45′ from the apparatus to a distance of several miles through the medium of receiving telephones. It is composed essentially of a movable plate carrying a carbon contact, which presses against a disk of carbon or metal, silver or platinum.

* "*Scientific American*" . . . . . xliii. 162.

Pan'to-graph. Statement and illustration, p. 1603, "*Mech. Dict.*"

Fenby, Br. . . . . * "*Engineering*," xxx. 8.
* "*Scientific American Sup.*," 3848.
* "*Scientific American Sup.*," 2506.
* "*Scientific American*," xli. 66.
Polar, *Napoli*, Fr. . . * "*Engineering*," xxvi. 427.

Pan'to-graph En-gra'ving Ma-chine'. A system of etching calico rolls by means of a pantographic apparatus.

A copy of the pattern to be engraved is enlarged by camera to any required size; this copy is then laid on a table forming a part of the machine; and over the lines of this copy the operator guides a stylus or tracing point, which, by being connected with suitable mechanism, causes a number of gravers or diamond points to come in contact with the roller, each point duplicating on its surface the exact copy, in miniature, of the original design. The roller is covered with a coating of varnish, and upon this coating the figures are etched. After this, the roller is immersed in nitric acid, where it remains till the metal has been eaten away to the required depth excepting where the varnish preserves the surface from the action of the acid.

Pan-to-graph'ic Cut'ter Form'ing En'gine. A milling machine for forming cutters for gear cutting.

An arrangement by which from a templet of the correct size, any required reduction may be made in the size of the cutter, preserving the correctness of shape. The gear cutter is turned nearly to the required form; the notches are cut in it, and the duty of the pantographic engine is merely to give the finishing touch to each cutting edge and give it the correct outline. — *Pratt & Whitney.*

Pan-tom'e-ter. (*Surveying.*) An instrument by Fouquier, for obtaining angular measurements. It is composed of two vertical cylindrical drums of the same diameter, one superposed on the other axially.

The lower has a socket beneath which rests on a staff, and the upper one turns on the axis and has two planes diametrically perpendicular acting as alidades. An object is viewed through one and the angle determined by aid of an opening and wire in the lower drum, then bring on the other object the opening and wire in the upper drum. The angle sought is then equal to that of the diametric planes of the two drums, and is read directly by aid of the divisions with which they are furnished.

Pan-top'ol-lite. A German dynamite containing a small proportion of naphthaline dissolved in the nitro-glycerine. Intended to prevent the formation of disagreeable nitrous vapors during explosion.

Pa'per. The statement, adopted from Pliny, and given on p. 1604, "*Mech. Dict.*," as to the mode of making paper from the *papyrus* reed, requires correction.

Pliny said a great many things from knowledge and still more from information, and in this case is not correct. He describes the cutting of the reed stalks into lengths and separating "by splitting the successive folds of the stalk with a needle."

A critical examination of the papyrus stalk shows that it does not have successive folds, but its triangular stalks have a single envelope and the pith on the inside must have been divided into slices by a knife, either in strips of such width as the side of the prism admitted, or else shaved round and round (like the operation of cork making) making a long spiral slice, as practiced from time immemorial in China and Formosa in making what is popularly called, by us, "rice paper," which has no rice in its composition but is a spiral shaving, made as just described (of the papyrus), from the pith of the *Aralia papyrifera*, which grows wild in Formosa. See p. 1938, "*Mech. Dict.*"

Materials for paper, shown or cited at the Centennial Exhibition, 1876: —

Common and Botanical Names.	Exhibited from.
Maguey, *Agava Americana*	Mexico, etc.
Maguey, *Agava Mexicana*	Mexico.
Spanish broom (*Esparto*), *Macrochoia tenacissima* .	Spain.
Banana leaves, *Musa*	Egypt.
Halfa, *Ligeum Spartium*	N. Africa.
China grass (Rhea), *Bœhmeria nivea*	Victoria.
New Zealand flax, *Phormium tenax*	New Zealand.

Agave, *Fourcroya gigantea* . . . . . Tropical America.
Cow-itch tree, *Lagunaria Pattersoni* . . . Norfolk Island.
Spanish bayonet, *Yucca aloifolia* . . . . . Victoria.
Spanish bayonet, *Yucca filamentosa* . . . . . Victoria.
Adam's needle, *Yucca gloriosa* . . . . . Victoria.
Adam's needle, *Sparmannia Africana* . . . . . Africa.
Adam's needle, *Hibiscus heteiophyllus* . . . Queensland.
Queensland hemp, *Sida retusa* . . . . . Queensland.
Victorian hemp, *Sida pulchella* . . . . . Victoria.
Queensland grass cloth, *Pipturus propinquus* . Queensland.
Flame tree, *Brachychiton acerifolium* . . . . Queensland.
Bottle tree, *Sterculia rupestris* . . . . . Queensland.
Tree nettle, *Laportia gigas* . . . . . Queensland.
Mulberry (*Kuwa*) . . . . . Japan.
Wild cherry (*Hi-no-ki*) . . . . . Japan.
Sisal hemp, *Agave sisilana* . . . . . Yucatan.
Pineapple, *Ananassa sativa* . . . . . Jamaica.
Pineapple, *Bromelia sylvestris* . . . . . Mexico.
Pineapple, *Bromelia penguin* . . . . . Jamaica.
Mohant tree, *Hibiscus arboreus* . . . . Tropical America.
Okra, *Malva* . . . . . Jamaica.
Yercum, *Calatropis gigantea* . . . . . Jamaica.
Bow-string hemp, *Sanseviera Zeylanica* . . . . Jamaica.
Ife tree, *Sanseviera Angolensis* . . . . . Angola.
Fig tree, *Ficus speciosa* . . . . . Brazil.
Milk weed, *Asclepias* . . . . . Brazil.
Diss, *Cyperus dives* . . . . . Egypt.
Cat-tail, *Typha latifolia* . . . . . Egypt.
Neilgherry nettle, *Urtica heterophylla* . . . . . India.
Puyba (puya flax), *Bœhmeria puoya* . . . . . India.
Kangra hemp, *Cannabis sativa* . . . . . India.
Barriala, *Sida rhomboida* . . . . . India.
Brown hemp, *Hibiscus cannabinus* . . . . . Bombay.
Roselle, *Hibiscus sabdariffa* . . . . . India.
Indian mallow, *Abutilon Indicum* . . . . . India.
Sun hemp, *Crotalaria juncea* . . . . . India.
Jubbulpore hemp, *Crotalaria tenuifolia* . . . . India.
Jute, *Corchorus olitorius* . . . . . India.
Nettle, *Urtica incisa* . . . . . Queensland.
Paper mulberry, *Broussonetia papyrifera* . . Queensland.
Hollyhock tree, *Hibiscus splendens* . . New South Wales.
Hollyhock tree, *Abutilon venosum* . . . . . S. America.
Hollyhock tree, *Abutilon mollis* . . . . . S. America.
Hollyhock tree, *Abutilon Bedfordianum* . . . S. America.
Hollyhock tree, *Abutilon striatum* . . . . . S. America.
Ribbon tree (lace bark), *Plagianthus betulinus* . N. Zealand.
Club rush, *Scirpus fluviatilis* . . . . . Australia.
Sedge grass, *Carex appressa* . . . . . Australia.
Gallingall rush, *Cyperus lucidus* . . . . . Australia.
Gallingall rush, *Carex pseudo-cyperus* . . . . . Australia.
Sword grass, *Gahnia psittacorum* . . . . . Australia.
Sword grass, *Cyperus vaginatus* . . . . . Australia.
Sword grass, *Lepidosperma elatius* . . . . . Australia.
Coast sword grass, *Lepidosperma gladiatum* . . Australia.
Sleuder sword grass (mat grass), *Lepidosperma flexuosa* . . . . . Australia.
Black reed (cutting grass), *Cladium radula* . . . Australia.
Stringy bark, *Eucalyptus obliqua* . . . . . Australia.
Messmate, *Eucalyptus fissilis* . . . . . Australia.
Swamp tea-tree, *Melaleuca ericifolia* . . . . . Australia.
Swamp tea-trce, *Melaleuca genistifolia* . . . . Australia.
Swamp tea-tree, *Melaleuca squarosa* . . . . . Australia.
Flame tree, *Sterculia acerifolia* . . . . New South Wales.
Bottle tree, *Sterculia diversifolia* . . . . . Victoria
Bottle tree, *Sterculia lucida* . . . . . Victoria.
Bottle tree, *Sterculia fœtida* . . . . . Malaysia.
Lye plant, *Commersonia Fraseri* . . . . . Queenslaud.
Lye plant, *Dombeya Natalensis* . . . . . Natal.
Wire grass, *Ehrhasta tenacissima* . . . . . Australia.
Wire grass, *Poa Australis* . . . . . Australia.
Plume grass, *Arunda conspicua* . . . . . New Zealand.
River rush, *Isolepus nodosa* . . . . . Australia.
Sea-coast rush, *Juncus maritimus* . . . . . Australia.
Sea-coast rush, *Juncus vaginatus* . . . . . Australia.
Sea-coast rush, *Dianella latifolia* . . . . . Australia.
Sea-coast rush, *Dianella longifolia* . . . . . Australia.
Dragon tree, *Dracœna Draco* . . . . . Teneriffe.
Spear lily, *Doryanthes excelsa* . . . . . Eastern Australia.
Bulrush, *Typha angustifolia* . . . . . Australia.
Jaggery palm, *Caryota urens* . . . . . Queensland.
Screw pine, *Pandanus utilis* . . . . . Australia.
Common rush, *Juncus pauciflorus* . . . . . Australia.
Tussock grass, *Xerotes longifolia* . . . . . Australia.
Currijong, *Pimelia axiflora* . . . . . Queensland.
Currijong, *Dais cotinifolia* . . . . . Natal.
Currijong, *Pittosporum cranifolium* . . . . . Natal.
Manila hemp (*abaca*), *Musa textilis* . . . . . Philippines.
Baobab, *Adamsonia digitata* . . . . . Tropical Africa.
Baobab, *Strelitzia regina* . . . . . South Africa.
Baobab, *Heliconia gigantea* . . . . . Tropical America.
Urania (*Ravenala*), *Madagascariensis* . . . . Madagascar.
Urania, *Pterospermum acerifolium* . . . . . Mauritius.
Urania, *Guazuma ulmifolia* . . . . . Mauritius.
Urania, *Melochia liliacefolia* . . . . . South Africa.
Sago palm, *Sagus ruffia* . . . . . Mauritius.
Sago palm, *Sagus saccherifera* . . . . . Mauritius.
Sago palm, *Livistona mauritiana* . . . . . Mauritius.
Sago palm, *Sanseviera zebrina* . . . . . Mauritius.
Sago palm, *Sanseviera latifolia* . . . . . Mauritius.
Sago palm, *Sanseviera cylindrica* . . . . . Mauritius.
Sago palm, *Colocasia antiquorum* . . . . . India.
Mulberry, *Morus tartarica* . . . . . Tartary.
Mulberry, *Alpinia magnifica* . . . . . Tropical Africa.
Mulberry, *Cordia myxa* . . . . . Egypt.
Mulberry, *Ixova corylifolia* . . . . . .
Panama hat-straw, *Carludovica palmata* . . . . Ecuador.
Bamboo, *Bambusa vulgaris* . . . . . Asia.

The Victoria collection at the Philadelphia Exposition embraced samples of paper made from plants growing in Victoria, Australia, were as follows :—

PAPER MADE FROM BARK OF

Paper mulberry tree, *Broussonetia papyrifera.*
Salvia Canariensis.
Dais continifolia.
Stringybark, *Eucalyptus obliqua.*
Messmate, *Eucalyptus fissilis.*
Soft-leaved abutilon, *Abutilon mollis.*
Veined lantern flower, *Abutilon venosum.*
Currijong, *Pimelia axiflora.*
Lye plant, *Commersonia Fraseri*, Queensland.
Thick-leaved pittosporum, *Pittosporum crassifolium.*
Queensland grasscloth plant, *Pipturus propinquus.*
Common tea tree, *Melaleuca ericifolia.*
Broom-leaved tea tree, *Melaleuca genistifolia.*
Victorian bottle tree, *Sterculia diversifolia.*
Flame tree, *Sterculia acerifolia.*
Chinese grasscloth plant, *Bœhmeria nivea.*
Victorian hemp, *Sida pulchella.*
Queensland hemp, *Sida retusa.*
Victorian yellow-wood, *Melaleuca squarrosa.*

PAPER MADE FROM STEMS OF

Victorian nettle, *Urtica incisa.*
Ehrharta tenacissima.
Carex appressa.
Carex pseudo-cyperus.
Isolepeis nodosa.
Few-flowered rush, *Juncus pauciflorus.*

PAPER MADE FROM STEMS AND LEAVES OF

Gahnia psittacorum, var. erythrocarpum.
Tall sword rush, *Lepidosperma elatius.*
Tall palm lily, *Cordyline indivisa.*
New Zealand flax, *Phormium tenax.*
Pampas grass, *Gynerium argenteum.*
Plume grass, *Arundo conspicua.*
Giant lily, *Fourcroya gigantea.*
Cyperus sp.
Coast rush, *Juncus maritimus.*
Small sheathed rush, *Juncus vaginatus.*
Large sheathed rush, *Juncus vaginatus.*
Coast sword rush, *Lepidosperma gladiatum.*
Native bulrush, *Typha angustifolia.*
Scirpus fluviatilis.
Marica Northiana.
Native tussock grass, *Xerotes longifolia.*
Screw pine, *Pandanus utilis.*
Cyperus lucidus.
Swamp moss, *Conferva sp.*
Dianella latifolia.
Jaggery palm, *Caryota urens.*

De Naeyer & Co., of Willebroeck, Belgium, showed at the Paris Exposition of 1878, paper manufactured from the following materials, and furnished the statement of percentage of fiber yielded :—

Woods.

Common and Botanical Names.	Yield per cent.
Heath, *Erica vulgaris*	27.14
Filbert trees, *Corylus avellana*	31.50
Alder, *Alnus glutinosa*	34.30
Bamboo, *Bambusa thonarsu*	34.82
White pine, *Abies pectinata*	34.60
Horse chestnut, *Æsculus hippocastanus*	38.26
Oak, *Quercus robur*	29.16
White poplar, *Populus alba*	35.81
Red pine, *Pinus sylvestris rubra*	32.28
Elm, *Ulmus campestris*	31.81
Ash, *Fraxinus excelsior*	32.28
Black alder, *Rhamnus frangula*	37.82
Fir, *Pinus sylvestris*	35 17
Osier, *Salix alba*	29.50
Canadian poplar, *Populus Canadensis*	36.88
Beech, *Fagus sylvatica*	30.90
Pitch pine, *Pinus Australis*	31.08

Walnut, *Juglans regia*	26.52
Willow, *Salix alba*	37.82
Birch, *Betula alba*	38.80
Italian poplar, *Populus Italica*	36.12
Acacia, *Robina pseudoacacia*	34.10
Lime tree, *Tilia Europea*	38.16
Rattan, *Calamus verus*	29.19
Aspen tree, *Populus tremula*	35.00

HERBACEOUS PLANTS, ETC.

Camelina, *Camelina sativa*	29.16
Bent grass, *Agrostis spica venti*	45.82
Buckwheat, *Fagopyrum esculentum*	30.60
Marsh rush, *Scirpus palustris*	41.70
Banana, *Musa ensete*	31.81
Mateva, *Hyphœne Thebaica*	26.08
Oats, *Avena sativa*	35.08
New Zealand flax, *Phormium tenax*	32.71
Asparagus stalks, *Asparagus officinalis*	32.56
Marsh grass, *Glyceria aquatica*	38.80
Maize, *Zea maïs*	40.24
Reed, *Phragmites vulgaris*	41.57
Canna, *Canna*	20.29
Rye, *Secale cereale*	44.12
Giant nettle, *Urtica dioica*	21.66
Sugar cane, *Saccharum officinarum*	29.15
Barley, *Hordeum vulgare*	36.21
Sedge, *Carex*	38.86
Wheat, *Triticum sativum*	43.14
Frumenteau, *Baldengera Arundinacia*	46.17
Blue flag, *Enodium cæruleum*	40.07
Hop, *Humulus lupulus*	34.84
Canary grass, *Phalari Canariensis*	44.16
Wild broom, *Spartium scoparium*	32.43
Dog's grass, *Triticum repens*	28.38

An *astronomical tower* 29′ in diameter was constructed of paper at the Polytechnic Institute, Troy, N. Y.

A *paper church* near Berlin has a capacity for nearly 1,000 persons. It is circular within, octagonal without. The reliefs outside and statues within, the roof, ceiling, the Corinthian capitals, are all papier mache, rendered water-proof by saturating in vitriol, lime water, whey, and white of eggs.

Bricks are made of paper pulp from rough materials in Wisconsin.

Barrels of paper are made in numerous factories in the United States.

Paper chimney-pots are made in Breslau, and are light and durable. Before the paper pulp is molded and compressed into the required shape, it is treated with chemicals which render it non-inflammable.

See also — asparagus	"*Scientific Amer.*," xxxvii. 318.
Asparagus	"*Scientific Amer.*," xxxvii. 52.
Bagasse	"*Scientific American*," xlii 50.
Bamboo	"*Scientific Am.*," xxxiv. 49, 88.
	"*Scientific American Sup.*," 288.
	"*Eng. & Min. Jour.*," xxviii. 128.
Banana fiber	"*Scientific American*," xliii. 66
Esparto grass	"*Scientific American*," xl. 170.
Grass	"*Scientific American*," xli. 311.
Palmetto fibre	"*Scientific American*," xli. 35.
Hop plant	"*Scientific American*," xli. 87.
Palm fiber	"*Man. & Builder*," xii. 247.
Photolithographic	"*Scientific American Sup.*," 1323.
Poke-weed, Phytolacca	"*Scientific Amer.*," xxxix. 134.
Rice paper of China	"*Scientific American Sup.*," 2408.
Woods & plants yielding paper, list	"*Scientific Amer.*," xxxix. 212.
Yucca	"*Min. & Sc. Press*," xxxv. 289.

Proteaux's "Practical Guide for the Manufacture of Paper and Boards."

Arrowsmith's "Paper Hanger's Companion."

Pa'per, Print'ing, Books. See under the following: —

Agave.	Bottom plate.
Albumenized paper.	Calendering machiue.
Asbestos paper.	Calender rolls.
Backing pan.	Cameo press.
Bank note paper.	Card and ticket cutter.
Bank note press.	Cardboard cutter.
Blank work folder.	Cardboard machine.
Blotting paper.	Chromo-lithographic mach.
Board cutter.	Color printing.
Book backing machine.	Composing machine.
Book backing vise.	Coupon ticket machine.
Bookbinder's plow.	Cutcher.
Bookbinder's press.	Damping apparatus.
Book sawing machine.	Distributing table.
Book sewing machine.	Electrotype.
Book stabbing machine.	Electrotype molding machine.
Book stitching machine.	Electrotyping battery.
Book trimmer.	Embossing machine.
Envelope machine.	Perforating machine.
Euvelope printing press.	Photolithographic paper.
Facsimile printing press.	Postage stamp.
Fiber-faced paper.	Printing machine.
File holder.	Printing press.
Finishing stand.	Proof press.
Fire-proof paper.	Pulp boiler.
Folding and perforating m.	Punching press.
Folding machine.	Rag boiler.
Gage table shears.	Rag knife.
Gilding press.	Rag washer.
Gold paper.	Roller bar.
Grounding machine.	Rounding machine.
Inking pad.	Ruling-pen holder.
Lace paper.	Safety paper.
Lettering stamp.	Sheet calender.
Lithographic press.	Shoot board.
Lithographic stone dresser.	Snatching rollers.
Lithographic stone polish. m.	Steel pen.
Mailing table.	Stereotype.
Matrix-rolling machine	Stereotype beveling machine.
Mechanical printer.	Stereotype dressing table.
Mechanical quoin.	Stereotype melting furnace.
Message copying press.	Stop-cylinder printing mach.
Motor printer.	Striker.
Multicolor printing press.	Taking-off apparatus.
Music printing.	Technograph.
Numbering chase.	Ticket printing.
Pantographic engraving m.	Tissue paper.
Paper.	Transparent paper.
Paper articles.	Two-revolution press.
Paper-bag machine.	Type.
Paper barrel.	Type composing machine.
Paper building.	Type machine.
Paper calendering machine.	Type-making and setting m.
Paper clipping machine.	Type writer.
Paper collar machine.	Typographic machine.
Paper coloring machine.	Wall paper.
Paper cutting machine.	Wall paper machine.
Paper cutting and winding m.	Wall paper polishing mach.
Paper enamel.	Wall paper sticking machine.
Paper glazing machine.	Washer.
Paper knife grinder.	Water proof paper.
Paper making.	Wet printing press.
Paper press.	Wet broke.
Paper pulp engine.	Wood paper.
Paper rolliug machine.	Wood-paper-stock assorter.
Pasteboard cutter.	Wood pulp.
Perfecting press.	Wood rasping machine.
Perforated board.	Wood stock boiler.

Pa'per Bar'rel. Barrels are made from molded pulp, formed in sections, and then united; or of paper in layers.

The process of preparing the paper consists in subjecting three layers of paper (called straw-board), cemented together, to a hydraulic pressure of more than 100 tons. This produces a compact, solid substance of great resisting power. These sheets are run through machinery which dovetails the ends, making them ready for joining, and turns the edges. It is passed through another machine, which gives the cylindrical shape. This saves 25 per cent. in packing space over the usual barrel. The outside of the barrel, after being ornamented and rendered perfectly air and water proof, is ready to put together. One operator can easily manufacture 150 per day, while from 15 to 20 have been considered a good day's work in making wooden barrels. Either wooden or paper heads can be used. The former are turned, and the latter are pressed out and stamped in dies. The hoops are strongly united bands of paper Each part of the barrel, hoop, head, and cylinder, is made complete. Empty barrels can be packed the one within another, and put together as required. The weight of a paper barrel is about one-half that of a wooden one. — *Thompson.*

By another method straw pulp is run into a mold made in the shape of a half-barrel, cut vertically. The ends are of paper, but are protected by wood. The staves are three-eighths of an inch thick.

See also "*Manufacturer & Builder*," xii. 149.

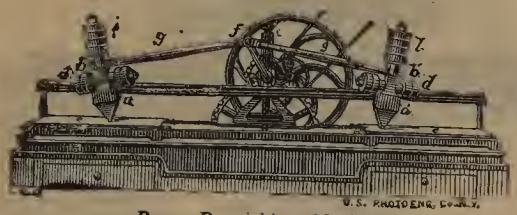
Pa'per Bur'nish-ing Machine'. A machine for putting a polish on paper. The action is more energetic than that of the calender, which depends upon mere pressure.

See CALENDERING MACHINE, Figs. 499, 500, pp. 152, 153, *supra.*

The substitution of glazed rolls for the burnishing of marbled and colored papers with polished agates, etc., has not equaled the previous result. Fig. 1867 is a machine by M. Alauzet, of Paris, for manipulating the burnishing stone, and thus economizing the cost without impairing the beauty of the imparted surface. This machine, which may be used for dyed and undyed paper, is double acting; the sheets of paper

are represented by *e*, while *a* shows the burnishing stone guided and moved by the bar *b d t* and the rod *g*, which is

Fig. 1867.



Paper Burnishing Machine.

connected with the crank *f*. The weights *t* and *l* may be increased or diminished according to requirements.

See also PAPER GLAZING MACHINE and PHOTOGRAPH BURNISHER.

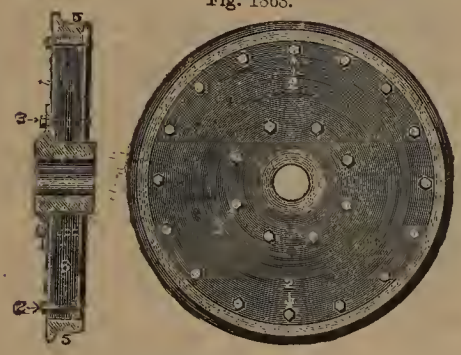
Pa'per Cal'en-der-ing Ma-chine'. Poole's super-calender rollers, Fig. 499, p. 152, *supra*.

Pierron & Dehaîtres French calendering machine, Fig. 500, page 153, *supra*.

See also PLATER; SUPER CALENDER, *infra*.

See also PAPER GLAZING MACHINE, *infra*.

Fig. 1868.



Paper Car Wheel.

2. Tire-bolt.
3. Hub-bolt.
5. Tire.
6. Compressed paper.

Pa'per Car'bon Lamp. A form of incandescent electric lamp in which a slip of paper reduced to carbon is used as the illuminated agent in a glass globe with an atmosphere of nitrogen. The carbonized strip of paper is the substitute for other forms of carbon, such as rattan or bamboo bark, or the metal platinum. The mode of disposing the carbon arc and its connections is shown in Fig. 938, Plate XIV., opp. p. 300, *supra*.

Pa'per Car'pet.

Paper is rendered hard and tenacious by subjecting the pulp to the action of chloride of zinc. After it has been treated with the chloride, it is submitted to a strong pressure, thereafter becoming as hard as wood and as tough as leather.

"A paper carpet is now made in England, and designed to imitate parquet flooring, the paper being printed in patterns to imitate different woods from photographs, so that the resemblance is perfect. The floor is first prepared by being made perfectly level, and the crevices filled up with plaster-of paris; over the surface, as thus prepared, *hession* (paper treated with chloride of zinc), is stretched, and on this first lining paper, and then the patterned paper, is pasted, the whole being finished with a coating of a peculiar hard and wear-resisting varnish." — "*Furniture Trade Journal*," Br.

See also LEATHER, ARTIFICIAL, *supra*, and references there cited.

The imitation of Japanese paper, for decorative purposes, is made by the Pavey Co., of London.

It is made of hemp and jute, with a small percentage of animal matter. It is used for lambrequins, window and bed curtains, tapestry, blinds, valances, upholstery, etc. It is made and printed in imitation of silk, woolen, cotton stuffs, the brocades of Lyons, reps, woolen and silk damasks of Paris and Bordeaux, and the cretonnes of Mulhouse, while it retains the peculiar Japanese characteristics.

The paper is first formed into an endless roll, and is perfectly white in color. Afterward it is taken to an embossing machine, which impresses it slightly, and then the design is printed from electrotype plates, first cast from the wood and formed upon a roller, as in wall-paper printing.

Pa'per Car'-wheel. (*Railway.*) A car wheel with steel tire and a web of compressed paper between plates which are bolted to the hub and tire. It is shown by section, and also by elevation, in Fig. 1868.

The central portion of the wheel is entirely of thicknesses of paper, united by paste and compressed by hydraulic machinery to the consistence of wood, but without the liability to split, which wood has more or less; the hub and the tires are of steel. One of these wheels, used under a Pullman car, has run for eight years, and for a distance of 302,900 miles.

Pa'per Clip'ping Ma-chine'. A machine for trimming the edges of books, or of paper in piles. See PAPER CUTTER.

Pa'per Col'lar Ma-chine'. See p. 1619, "*Mech. Dict.*"

The Lockwood machine works from an endless web of paper, or of cloth and paper, the width of the web being slightly greater than the length of the collar required. The web passes over rollers, and then beneath an intermitting descending platen, which has two sets of dies by which the collars are cut, creased, button-holed, stitch-marked, and embossed with the name and number at the rate of 30,000 per day. The material is fed intermittingly and receives the button-holes, stitch marking, and embossed number by one set of dies, then is advanced beneath the cutting-out dies, both sets of dies descending at once, but operating consecutively upon the paper.

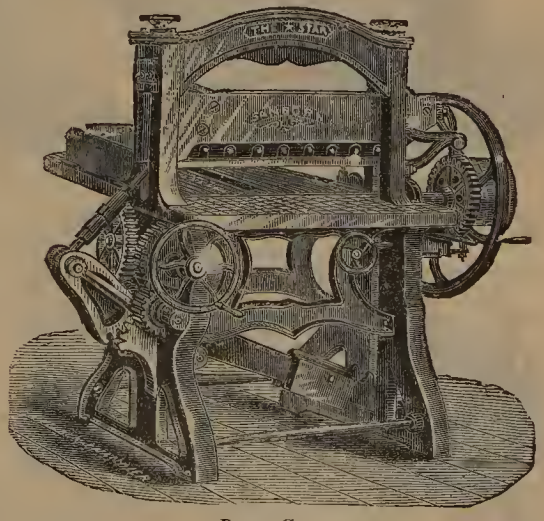
When paper only is used for the collar, three strips of gummed cloth are fed from spools, so as to be exactly over the places for the three button-holes. The patches are cut from these and automatically damped, deposited upon and fastened to the web in the places where the holes are to be cut.

A *forming machine* then bends the paper collar at the crease, taking them in endwise, and discharges them at the rate of 50,000 per day.

Pa'per Cut'ter. A machine for cutting paper in pile. In the Sanford cutter, Fig. 1869, the knife is brought down obliquely upon the pile and returns by a quick upward stroke. The table has rules and lines for cutting to measure. The paper clamp is moved independently.

Another form of paper cutter is that for scoring and cutting paper boards for boxes, notching the corners, and scoring the joints. — *Sanborn.*

Fig. 1869.



Paper Cutter.

* "*Manufacturer and Builder*" . . . . . xi. 193.
* "*Scientific American*" . . . . . xl. 310.

See Figs. 3524, 3525, pp. 1620, 1621, "*Mech. Dict.*"

See also BOOK TRIMMER, *Semple*, Fig. 384, p. 121; BOARD CUTTER, Fig. 354, p. 112; CARD CUTTER, Figs. 539-541, p. 166, *supra*.

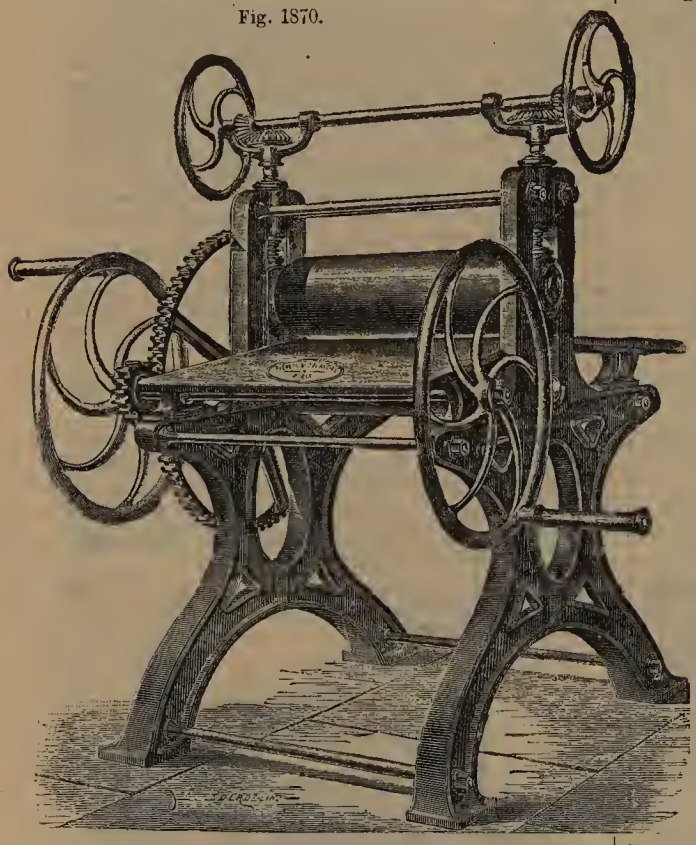
Pa'per E-nam'el. Enamel for paper cards and papeterie.

For white, and for all pale and delicate shades, take 24 parts by weight of paraffine, add thereto 100 parts of pure kaolin (China clay), very dry, and reduced to a fine powder. Before mixing with the kaolin the paraffine must be heated to fusing point. Let the mixture cool, and it will form a homogeneous mass, which is to be reduced to powder and worked into a paste in a paint mill with warm water. The enamel is then ready for application. It can be tinted to any desired color.

Pa'per Gla'zing Rol'ler. A machine through which paper or card is passed to give to it a burnished surface.

The machine shown in Fig. 1870 is that of Pierrin et Dehaître, of Paris. The paper is passed between two rollers, the lower one of which is driven, and the resistance of the upper one gives a sliding pressure which compacts the surface of the paper in the manner of a burnisher.

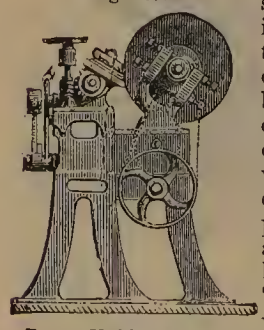
Fig. 1870.



French Paper-glazing Machine.

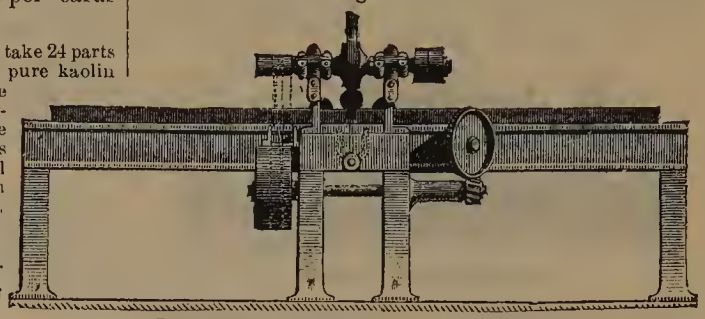
Pa'per Knife Sharp'en-er. The machine of Bell, of Lucerne (Switz.), is shown in Figs. 1871, 1872; it is adapted for knives up to 1.5 meter in length. The emery wheel is in fixed bearings, and the knife, secured to a slide rest, traverses in front of it. The wheel is .45 to .5 m. in diameter and makes 600 turns per minute. The knife is advanced to the emery wheel by hand wheel and screw. The motion of the grinding wheel is communicated to the slide rest which passes the knife to and fro by an alternate movement. See GRINDING MACHINE.

Fig. 1871.



Paper Knife Sharpener. (End View.)

Fig. 1872.



Paper Knife Sharpener. (Side Elevation.)

Pa'per Ma-chin'e-ry, etc.

Articles of, machinery for making	"*Sc. Amer.*," xxxvi. 339.
Barrel	"*Man. & Build.*," xii. 149.
Belting, *Crane*	*Cooper's* "*Belting*," 198.
Box	*Laboulaye's* "*Dict.*," iv., ed. 1877, article "*Sac.*"
Carbon lamp, *Edison*	"*Van Nostrand's Mag.*," xxiii. 1.
Carbon paper apparatus.	
Liebert, Fr.	* "*Sc. Amer. Sup.*," 2438.
Coloring machine	"*Sc. Amer.*," xxxv. 354.
Cutting machine.	
Brown & Carver	* "*Engineering*," xxi. 525.
Feister	* "*Sc. Amer.*," xliii. 178.
Cutter, "Diamond."	* "*Sc. Amer.*," xxxix. 386; xl. 310.
Schlenker	* "*Man. & Builder.*" xi 193.
Dome, observatory	"*Van Nostrand's Mag.*," xx. 448.
Fire-proof	"*Sc. Amer. Sup.*," 2511.
Folding mach., *Forsaith*	* "*Man. & Builder*," viii. 1.
Hardening	"*Sc. Amer.*," xxxiv 310.
Japanese, on, *Munroe*	* "*Engineer*," xli. 415.
Japanese, Ogi	* "*Engineer*," xli. 353.
Leather	"*Sc. Amer.*," xlii. 274.
Making, Albion Paper Mills	* "*Sc. Amer.*," xlii. 207.
Making, technology of.	
Arnot	"*Sc. Amer. Sup.*," 1733, 1750, 1845, 1862, 1879, 1956.
Machinery	"*Sc. Amer.*," xxxvi. 339.
Japanese	"*Sc. Amer.*," xxxiv. 339; xxxv. 100.
Mill, Japanese, Ogi	"*Engineering*," xxi. 395, 422.
Maché molds	"*Man. & Builder*," ix. 144.
Negatives, pap. by *Abney*	"*Sc. Amer. Sup.*," 1891.
Papyroxyline	"*Sc. Amer. Sup.*," 1752. See also GUN COTTON.
Preservative, mildew, etc.	"*Sc. American*," xli. 36.
Press	* "*Sc. American*," xli. 82.
Press, *Jones*	* "*Sc. American*," xli. 22.
Toggle motion.	
Boomer & Borchrt	* "*Sc. Amer.*," xlii. 242.
Pulleys & pulley covers	*Cooper's* "*Belting*," xv.
Pulp, black, recipes	"*Sc. Amer. Sup.*," 3971.
Pulp boiler, *Roeckner*	* "*Sc. Amer. Sup.*," 698.
Pulp boxes	"*Iron Age*," xvii., April 13, 23.
Pulp engine	"*Sc. Amer.*," xxxvi. 403
Pulp mach., *Lebrousse*	"*Sc. Amer. Sup.*," 2704.
Sheathing for vessels	"*Iron Age*," xxiv., Sept. 18, p. 1.
Splitting	"*Sc. American*," xl. 6.
Tester	* "*Sc. Amer.*," xxxviii. 69.
Testing machine, *Chauvin & Marin-Darbel*, Fr.	* "*Engineering*," xxvi. 185.

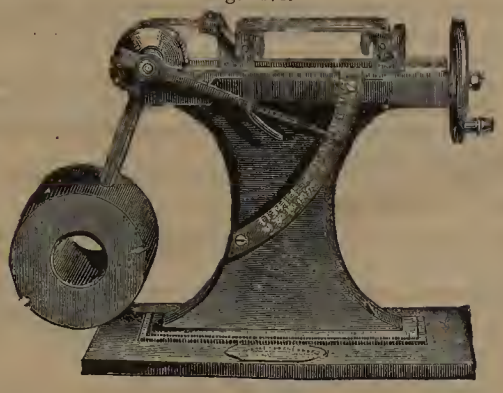
Pa'per Rol'ling Ma-chine'. See PAPER GLAZING ROLLER, Fig. 1870, *supra*; PLATES, *infra*; CALENDERING MACHINE, Figs. 499, 500, pp. 152, 153, *supra*.

Pa'per Test'er. A machine in which the tensile strength of a strip of paper of a given width is ascertained.

In Fig. 1873 the paper is tested by the direct action of a weight, avoiding the variations which arise in the use of springs.

The strip of paper is secured by cam clamps in the two holders. By rotation of the hand wheel the clamps are separated, and the strain is indicated by the finger against the graduated arc.

Fig. 1873.



Paper Tester.

Chavin & Marin-Darbel. . * "*Sc. American*," xxxviii. 69.
* "*Sc. American*," xxxix. 211.

Pa'per Weight. (*Glass.*) Ornamental blocks or globes made in various ways. See CAMEO INCRUSTATION; FILIGREE; VITRO DE TRINO; MILLEFIORI; and list on pp. 975, 976, "*Mech. Dict.*"

Pa'per Wet'ting Ma-chine'. The bundle of paper is placed on the bank, and fed in quires, either open or folded, to guides on the feed table. At the proper time the table advances and enters the paper between two cylinders covered with felt, the lower one of which runs in a trough of water. As the paper issues from these cylinders, it passes between a top and bottom sprinkler, by which additional water can be put on, and the quantity can be regulated at pleasure. The paper is then conveyed by cords to a sheet-flyer, which lays it on a table suspended on springs. These springs are adjusted to suit the weight of the paper, so that the table falls as the weight increases, and thus keeps the top of the pile always at the same height. — *Hoe.*

Pa-pyr'o-graph. Known also by other names. See HECTOGRAPH; COPYGRAPH; MANIFOLD, etc. See also GELATINE COPYING PROCESS, and references *passim*.

Par-a-bol'ic Il-lu'min-a'tor. (*Optics.*) Beck's. A means of illuminating opaque objects under the microscope.

It consists of one half of the upper portion of a parabola made of polished silver, and slides by means of a fitting, up and down upon the outside tube of the object glass. All parallel rays falling upon the silver surface will be reflected to the focus of the parabola which is of necessity in the optic axis of the microscope, at the point where the object under examination is situated. See Fig. 3545, p. 1629, "*Mech. Dict.*"

Par'a-cen-te'sis In'stru-ments. (*Surgical.*) Instruments for tapping a cavity.

For Paracentesis abdominis: —

Drainage tubes.	Drainage canula.
Trocars.	Hollow trocar.
Aspirators.	Clamp forceps.
Aspirator needles.	

For Paracentesis corneæ: —

Trocars.	Needles.

For Paracentesis thoracis: —

Dieulafoy's Aspirator, Fig. 6665, p. 2629, "*Mech. Dict.*"

Par'a-chute Light. A device invented by General Boxer and used in the British military service as a means of revealing the enemy's position and movements at night.

It forms, when closed, a large shell, expanding into a huge umbrella, 15′ high, when opened, the cup of composition which is suspended being designed to burn 4½ minutes.

The star shell, which has been designed as a substitute, is much smaller and more portable, and of comparatively trifling cost. It can be fired into the air from a mortar at the required angle to show the enemy's works, and burns with a brilliant light for about half a minute, long enough to take an observation and lay a gun, but not long enough to allow an adverse wind to bring the light back over the firing point, and so turn the advantage in favor of the enemy.

Par'af-fine. The mode of manufacture of paraffine and some of its uses are referred to on pp. 1629, 1630, "*Mech. Dict.*"

Its use depends upon several qualities: It is inodorous, white, clean, tasteless, non-oxidizable, water repellant, a non-conductor of electricity, inflammable, plastic.

It is used as a water-proofing material for fabrics and paper.
Lining wooden and metallic vessels.
Saturating paper as a water repellant, and to preserve contents from becoming rancid, — butter, for instance.
Trays and tanks for acids and voltaic batteries.
Insulator (electric).
For covering splints and other paraphernalia subject to septic influences.
As a polisher under the iron in fine laundry work.
As a vehicle of the fulminate in matches.
As a covering for cartridges.
Paper saturated with paraffine is used to inclose saccharine or saponaceous materials, etc.
Matthews lines with paraffine the enameled metal reservoirs of his soda fountain.
Hoe lines glass electrotype baths with paraffine.
Staunton preserves fruit and vegetables by films of paraffine.
Makes boxes, cans, or vessels air-tight by lining with paraffine; for holding meat, vegetables, fruit, butter, spices, etc.
Tucker has a lard package made of paper soaked in paraffine.
W. B. Guernsey saturates with paraffine the pores of wooden cases for containing butter, etc.
Paper by *Grostowsky* . . "*Scientific American Sup.*," 1898.

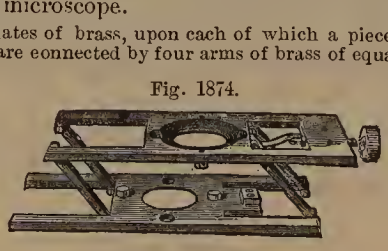
Par'a-kite. A series of kites, the smaller in advance and increasing in area, are flown *en suite*. The largest and last in the series is 36′ × 30′, and is intended to raise a man from the ground to an elevation of several hundred feet to observe the position of an enemy.

Experimented with at Woolwich, England.
"*Manufacturer & Builder*" . . . . . viii. 13.
"*Iron Age*" . . . . . * viii. 300.

Par'al-lel Com-pres'sor. (*Optics.*) Beck's. A means for holding or compressing an object under the microscope.

Two plates of brass, upon each of which a piece of glass is fixed, are connected by four arms of brass of equal length,

Fig. 1874.



Parallel Compressor.

giving a parallel movement to the plates. These plates are gradually brought together by a screw at the end attached to one plate and working in a conical hole in the other.

Pa-ral'y-sis Ap'pa-ra'tus. (*Surgical.*) Electrical apparatus or supports for the limbs.

Glove for paralysis, with caoutchouc cords acting as extensors. Fig. 54, Part IV., *Tiemann's* "*Armam. Chirurg.*"
Leg apparatus, with artificial muscles, *Ibid.* . Fig. 70
Hemiplegia apparatus, *Ibid.* . . . . . Fig. 71
Paraplegia apparatus, *Ibid.* . . . . . Fig. 72

Par'a-mag-net'ic. (*Electricity.*) As opposed to dia-magnetic. Substances the poles of which, like iron, nickel, cobalt, etc., tend to move from the weak to the strong places of electro-magnetic force are called para-magnetic, or ferro-magnetic. — *Gordon.* See also MAGNETIC SCALE.

Par'cel-gilt. Meaning *partly gilt.* Silver ware gilt inside, as bowls, spoons, etc.

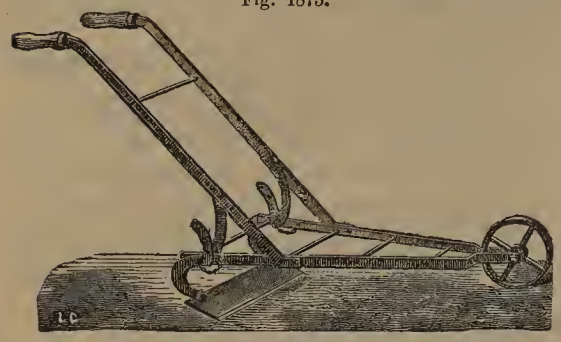
Par'cel Lift. A dumb waiter used in stores and warehouses.

Parch'ment Pa'per. Paper treated with dilute sulphuric acid. See p. 1633, "*Mech. Dict.*"

A new recipe is to use a bath of ammoniacal solution of copper, made by treating plates of copper with a concentrated solution of sal-ammoniac.

Par'er. A wide bladed hoe, drawn by a man or a horse, and used to pare the surfaces of walks in gardens and parks to kill weeds and grass.

Fig. 1875.



French Parer.

Pa'ri-an Bis'cuit. (*Ceramics.*) A fine-ware made by Minton and Copeland, of Stoke-upon-Trent, England. It is an ornamented semi-vitreous ware with a clear ring nearly like china, and is recognized as one of the best fine-wares introduced since the time of Wedgwood.

Par'ing Plow. See PARER, *supra.*

Park'e-sine. See CELLULOID, "*Mech. Dict.*," *et supra.*

Par'lor Or'gan. A reed or pipe organ; generally the former, of small size, adapted to parlor vestry, or school room.

History of the parlor organ in report of *H. K. Oliver* on Group XXV., in vol. vii., "*Centennial Exhibition Report*," p. 45.

Par'lor Skate. A skate on rollers.

Plimpton's improvement consists of an arrangement by which a skate is made to keep the floor without reference to the angle of the body or the sharpness of the curve turned. In the center of the sole of the skate is fixed a spherical spring of india-rubber, yielding to the slightest inclination of the foot, a mere change of motion by the well-known mechanical means causing the axles of the roller wheels to converge.

Part'ing Pul'ley. One capable of division, so that the parts can be attached to the shaft without dismounting the latter.

Fig. 1876.

Parting Pulley.

Part'ing Rail. (*Carpentry.*) A rail intermediate between the bottom and top rails of a door or partition.

Part'ing Strip. (*Carpentry.*) A narrow piece separating parts, as the strip between the upper and lower sashes in the window frame; or between the window and blind in a car.

Pas'sen-ger El'e-va'tor. See ELEVATOR.

Pass'ing Nip'pers. (*Nautical.*) A strong hank of untwisted but mailed yarn used in binding the messenger to the cable.

Paste. (*Ceramics.*) The material of porcelain and other fine grained pottery.

Known as *hard*, *soft*, *jasper*, *basalt*, *cream*, etc., names given to indicate relative quality or color, or names of fancy.

There are all gradations, from the soft paste of some *faïence*, which in many cases is so coarse as to be hardly deserving of the name, to the hard *china*, which resembles glass. See list under POTTERY.

Paste'board Cut'ter. See BOARD CUTTER, Fig. 354, p. 113; CARD-BOARD CUTTER, Figs. 539–541, p. 166, *supra.* Fig. 3665, p. 1636, "*Mech. Dict.*"

Paste Jag'ger. A pastry cook's convenience for notching the edges of cakes, pies, and pâtes.

Pas-tille'. An odoriferous pellet which emits an agreeable odor in burning. Its burning is due to the niter and charcoal in its composition.

French receipes: —

	Grams.
Oliban in tears	24
Storax in tears	24
Niter	16
Pulverized charcoal	124
Add for rose perfume: —	
Pulverized rose leaves	32
Essence of rose	2
For orange flower pastille: —	
Galbanum	24
Dried orange peel pulverized	32
Essence neroli	2
For vanilla pastille: —	
Galbanum	24
Girofle (cloves)	16
Vanilla	32
Essence cloves	1
Essence vanilla	16

Make into a mass with gum arabic, 4 grams; water two-thirds deciliter; mold and dry.

Pas-tille' Pa'per. Paper prepared with an odoriferous composition.

Take eascarilla bark 8 drachms, gum benzoin 4 drachms, yellow sanders 2 drachms, styrax 2 drachms, olibanum 2 drachms, charcoal dust 6 ozs., niter 1½ drachms, mucilage of gum tragacanth, sufficient quantity. Reduce the substances to a fine powder, form into a paste with the mucilage, coat the paper with this, and dry in an oven.

Pate Chan-geante'. (*Ceramics.*) A peculiar porcelain, made by Minton, which has changeable color according to the light or angle at which it is viewed, something like the changeable or shot silk. In daylight it has a grayish or celadon green color, and at night it appears pink.

This kind of chameleon paste was compounded by the chemist Regnault when director of the Sèvres establishment.

Pate de Bois. Wood pulped, and formed by compression into paper, carton, decorative cornices or panels.

Pa-tel'la Ap'pa-ra'tus. (*Surgical.*) Supports, braces, or splints for fractured patella. Fig. 3567, p. 1636, "*Mech. Dict.*"

Figs. 119–121, *Tiemann.* Dr. White's elastic patella hooks engage the upper and lower surfaces, and draw the portions together.

Pa'tent Ham'mer. (*Stone Working.*) The head holds a number of wide thin chisels held together by bolts.

It is used for giving a surface-finish to squared masonry. See Fig. 3160, p. 1444, "*Mech. Dict.*"

Pa'tent Plate. (*Glass.*) An English name for cylinder glass.

Pâte-sur-pâte. (*Ceramics.*) A form of decorative work in which one colored slip is laid upon another in bands, fillets, figures, and what not; sometimes to the number of a dozen or more. Wedgwood's imitation of the Portland vase is an eminent instance of the art, and Solon has also executed some very remarkable work.

The body is usually dark olive-green, brown, turquoise blue, or black, and the paste white, and laid on in relief, the lights and shades partly due to the thickness of the slip, which is in relief. After laying a sufficient thickness the artist scrapes away portions according to the requirements of the design, the dark background showing through in parts. Re-firing renders all translucent.

It is a very old process, having long been used in China on porcelain, and in India for common ware; the Sciude and Puujab pottery, for instance. In Scinde the pattern is pricked out on paper, and drawn by laying it upon the surface of the jar and dusting along the prickings. The effect is good, and articles are sold at from eight to twenty-four cents. See "*Handbook to the British Indian Section, Paris Exposition*," by Mr. George C. M. Birdwood, C. S. I., M. D. "*Paris Exposition* (1878) *Reports*," iii., pp. 113, 136, 137.

Path'find-er. (*Surgical.*) An instrument by Dr. Eldridge, of Yokohama, for finding urethral strictures by means of filiform whalebone bougies placed in any position by the rotating disk and screw.

Fig. 1877.

Pathfinder.

Pa-ti'na. The peculiar color on antiques, bronzes, and medals, due to exposure and time. It is counterfeited by various processes, either by oxidation or painting. *Orugo.*

The patina given to the Japanese bronzes is a trade secret, having been handed down from father to son for ages. M. Moriu has discovered that the patina of the celebrated black bronzes is due to the use of an alloy composed of copper, 80; tin, 4; lead. 10; zinc, 2; iron, 4; besides small proportions of gold, nickel, arsenic, and sulphur. Some of the bronzes analyzed show a proportion of lead varying from 10 to 20 per cent., added at the expense of the copper, and a quantity of 7 per cent. of tin. Molded in thin plates, this bronze is very easily worked, and the patina is developed by heat when the metal is subjected to a high temperature in a muffle furnace. It is, however, very brittle.

An imitation of patina can be produced by preparing a paint of carbonate of copper and any light alcoholic varnish, and applying it to the object with a brush. This green color penetrates the smallest recesses, and has, when dry, the appearance of patina. Carbonate of copper gives a blue patina, verdigris a light green, and intermediate shades of color can be obtained by mixing the two.

The French patina is effected upon bronzes of the ordinary strength by subsequent surface application. The process consists in preparing a ground by the action of chemicals having oxides and sulphides of copper as their bases. If different tints, black, brown, red, or green, be desired on the same object, it is sufficient to cover with a protecting varnish all portions of the surface except those to which it may be desired to give a certain hue; then when they have been treated for a sufficient time, they are covered with varnish, while the other parts of the surface now exposed are subjected to the action of the chemicals, and so on for as many tints as are required. See also MILDEW BRONZE.

Pat'tern-mak'ing Ma-chin'er-y. See p. 1638, "*Mech. Dict.*"

Jackson. Very elaborate methods and machinery. * "*American Artisan*," June, 1874.

See also SWEEPING MACHINE.

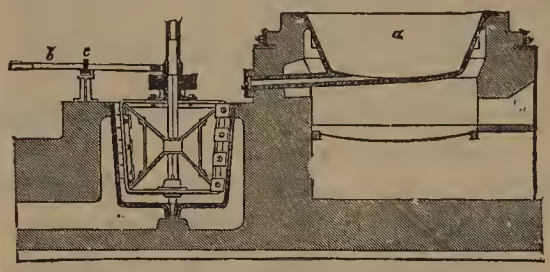
Joshua Rose. A series of valuable illustrated papers. "*Scientific American*," xxxiv. 261, * 293, * 325, * 357, * 388.

Pat'tin-son's Pots. A process for separating silver from lead by crystallizing the latter and removing it, the remainder being richer in silver.

The principle of the process is described and the apparatus shown on pp. 1638, 1639, "*Mech. Dict.*"

The improvement of Bourdehen, as practiced at Stolberg, Hozappel, and Rouin, is shown in Figs. 1878–1880.

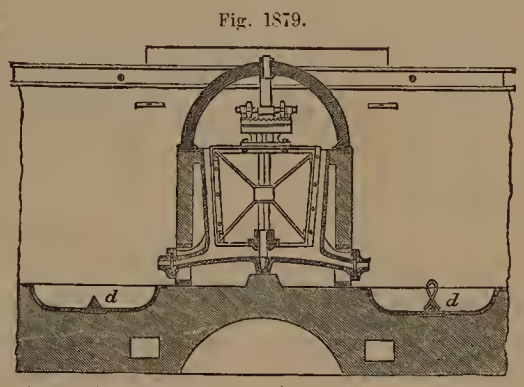
Fig. 1878.



Pattinson's Pots. (*Vertical Section on Line a B*, Fig. 1880.)

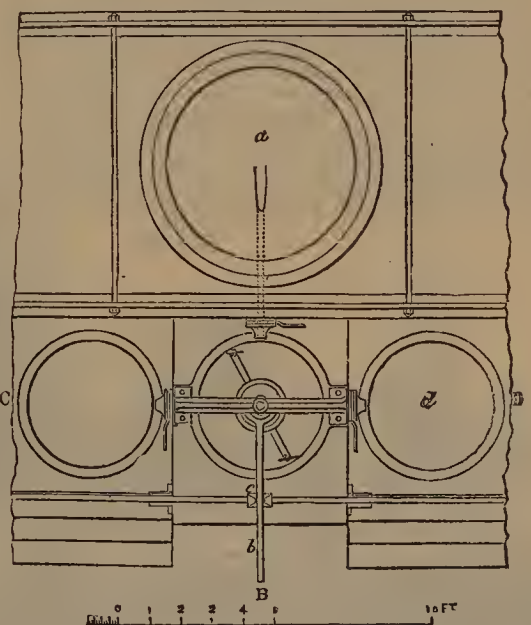
Each battery is composed of two kettles, the *melting* and *crystallization* kettles. The stirrer in the latter has two shafts, concentric, and moved in opposite directions. On the outer shaft is a stirrup-like frame from the sides of which project flat-edged scrapers; on the inner shaft are flat arms arranged spirally, and with oblique sides.

Fig. 1879.



Pattinson's Pots. (*Vertical Section on Line C D*, Fig. 1880.

Fig. 1880.



Battery for Mechanical Pattinsonizing. (*Plan.*)

The auriferous lead is melted in kettle *a*, and tapped through the iron spout into the lower kettle, where silver lead is added to lower the temperature. The stirrer is then set in motion, and small jets of water thrown upon the molten alloy. At the end of two hours the mass will have become pasty, when the stirrer and water-streams are stopped

and the mother-liquid is tapped into a heated pot, *d*. An iron hook is set in the lead while molten, and when the lead has cooled it is lifted out by means of a tackle. A fresh quantity of silver-lead, assaying about the same in silver as the remaining crystals, is added from the melting-kettle, *a*, to the crystallizing-kettle; during this operation the motion of the stirrer is reversed. The molten alloy soon liquefies the crystals, when the already-described operation is again performed. After this operation has been repeated 7 times, the poor lead contains but 0.0036 per cent. Ag. The crystals are melted, tapped off, taken to another kettle for re-melting and casting in pigs. An obstruction to the process is thus avoided. The mother-liquid is enriched in 8 operations. The mother-liquid resulting is then returned to the kettle and further enriched in 5 operations; it contains 2.4 per cent. Ag.

See *Percy's* "*Metallurgy of Lead*," p. 143.

Freiberg . . . . . *Painter's* "*Report Vienna Exposition*," iv., § F, pp. 69, 119.
Marseilles, *Rozan* . . *Ibid.*, pp. 11, 13.
Stolberg, *Boudehen* . *Ibid.*, pp. 149, 150.

Pave'ment. The subject is considered on pp. 1639–1642, and Plate XXXVIII., "*Mech. Dict.*"

The Figs. 1881–1884 exhibit the latest Parisian method of laying asphalt pavement.

The asphalt paving is of two kinds: the *asphalte comprimé*, that is, beaten and compacted with hot rammers; and the *asphalte coulé*, in which the material is spread with trowels.

The *asphalte comprimé* is especially employed around the churches, schools, theaters, concert halls, banks, and public buildings, on account of its freedom from noise; and generally for the additional reasons of cleanliness and salubrity in the places mentioned, and also in the main streets of the city. In the fashionable drives macadam is preferred on account of its freedom from slipperiness, and on the quays and warehousing quarters of the city the granite block system yet remains a favorite.

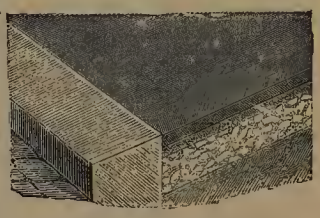
The first essential is a gravel foundation of sufficient thickness. Upon this a layer of concrete is placed to form a bed for the asphalt. There are but three materials used, and but three tools. The materials are: gravel screenings or sand; a silicious gravel in pieces, say from ½″ to 3″ in diameter; a gray hydraulic lime, usually Portland cement. The tools are: pointed shovels; two rakes with long bent prongs; two flat beaters, about 18″ square, and with handles set in obliquely. To this may be added 6 wheelbarrows, holding about a bushel each, and 18 water buckets, of 2½ gallons each.

Twenty men form a gang under a foreman, who work diligently in giving the final shape to the surface of the concrete, preserving the proper camber of the street, gage pegs being driven into the gravel foundation to work by, their tops representing the future surface of the asphalt.

The work now proceeds as follows: A man dumps a wheelbarrow load of sand, and another spreads it out to 4′ diameter. A bag of 3 pecks of lime is emptied on to it and spread evenly. On to this 3 barrow loads of silicious gravel are emptied, and the heap is trued up into conical form by shoveling from the foot of the heap and throwing it on to the apex. The materials are damp, and the lime clings to the gravel where it touches. The heap is torn down and built up in a spot alongside, the effect being to mix the materials of three different finenesses. The heap is presently flattened out to 6′ diameter, and a bucket of water distributed over it. As the middle is the wettest a cone is made at the center, so that a second bucket of water reaches the outside ring of the material. The conical heap is again constructed, and about a quarter of a bucket of water splashed by the hand upon the outside, — the outlying portions of the spread mass as it lay previously upon the ground.

It rests thus but a few minutes, and then is torn down, beginning at one side and throwing it, shovelful by shovelful, into a new location, a man with the three-pronged rake, like a manure hook, working it energetically and unceasingly as each new shovelful arrives at the heap. This mixing is a very important matter, as it insures that every particle of silicious rock shall be covered with the lime, and the heap now is, instead of the yellow of the flint gravel, a uniform gray. The water is only sufficient to cause the parts to adhere, and some little (without attempting to trace the chemical reactions) lost as such in the attack of the lime on the silex and in slaking.

Fig. 1882.

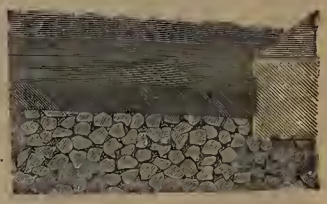


Section of Sidewalk. (*Trottoir.*)

The heap is ready in a few minutes to be removed in barrows and dumped on the line of working, where it is spread with shovels and with a second one of the three-tined rakes. Here the eye of the master is called for, and he gives it the final shape, so far as the shovels are concerned, due regard being paid to the gage pegs.

A man with the flat beater compacts and levels the surface by his blows, and the concrete is then surfaced with an inch thick coat of hydraulic lime mortar laid on with a trowel, and on this a coat of loose sand, which roughens it and forms a bond for the asphalt, which is afterward laid hot upon it, rolled and beaten. Of this presently. The sand appears to become partially imbedded in the yet soft mortar, and is in turn grasped by the asphalt. If the final asphalt were laid upon too smooth a surface it would be apt to fail in adherence and to flake off. Its mere adhesive quality is aided by a mechanical bind to the particles of sand which are, so to speak, riveted in the mortar, and it in the concrete.

Fig. 1883.



Section of Road.

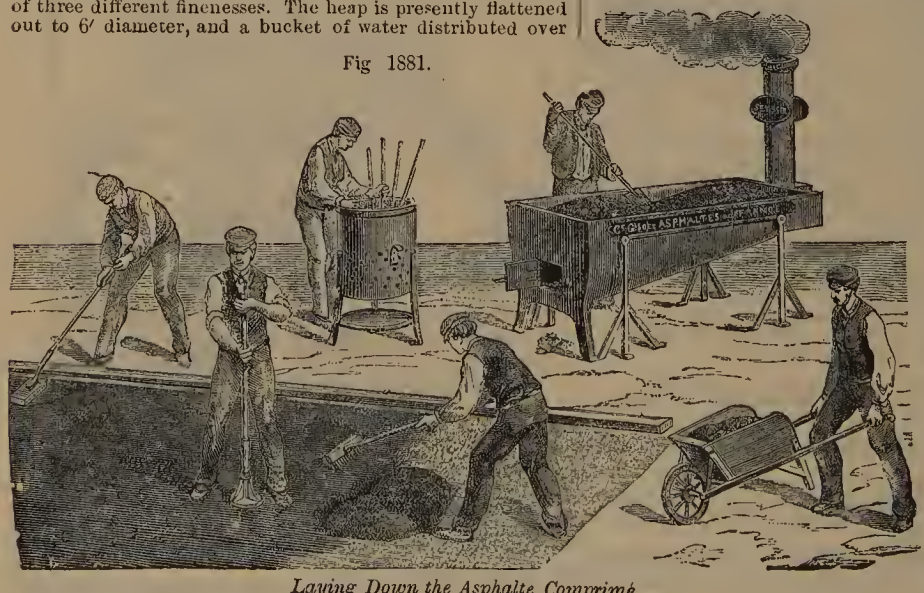
After a few days, the foundation — having been carefully guarded from disturbance by travel — having become fully set, the asphalt compound is brought hot in carts, and, being transferred to wheelbarrows, dumped upon the surface of the foundation concrete, and spread with rakes to a thickness of 4″. It is then lightly pounded with a very hot iron rammer with a circular face 10″ broad. A furnace is kept near by for heating the rammer. A second ramming with hard blows of the same rammer then takes place, condensing the asphalt to but little more than half its former thickness, and causing its intimate union with the rough surface of the layer beneath.

The final smoothing is given by a hot iron block, which is pushed and pulled over the surface, and burnishes down the elevations and the rough marks of the pounders.

The *asphalte coulé* is laid with a trowel upon the concrete basis, and is not pounded, as in the case of the *asphalte comprimé*. It is used for sidewalks, platforms and waiting saloons of railways, for prisons, skating rinks, baths, warehouses, breweries, and manufactories of all kinds.

To make a square meter of surface, 15 millimeters thick, it is necessary to use 1½ kilos of bituminous minerals; 23 to 24 kilos of Seyssel

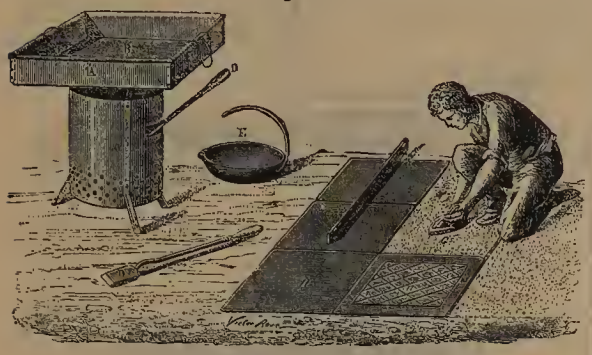
Fig 1881.



Laying Down the Asphalte Comprimé.

mastic; and 13 to 15 kilos of washed, dried, and sifted gravel.

Fig. 1884.



Imitation of Tile Pavement in Asphalt Coulé (Carrelages).

The material is also wrought up into the form of tiles (carrelages), and laid upon a soft and level bed of concrete, melted mastic being poured into the joints and fashioned by the rule and jointing iron.

The following statement of the expense of maintenance of the pavements of Paris is taken from the "*Annales des Ponts et Chaussées:* —

"For cleaning streets, machine sweepers are employed drawn by a single horse, cleaning about 5,000 square meters an hour.

"The cost of keeping in repair is quite different for the different avenues.

"The asphalt roadways have a joint area of 225,120 sq. meters, to which should be added about 34,000 sq. meters for the walks through the macadamized streets. The price of construction varies from 12 fr. to 15 fr. per sq. meter.

"The repairing is done by contract for 1.10 fr. per sq. meter per year for the roadways, and 1.70 fr. for the walks.

"The mean cost of repairing roadways in Paris, which was 1.08 fr. in 1870, has been reduced to 0.82 fr. This reduction is due especially to a change in many places from macadam to paved roadways. The mean cost of repairing pavement never exceeds 0.60 fr., while macadam roadways cost 1.80 fr. per sq. meter. The latter should therefore be replaced, except where they serve as promenades and ornaments, as in the boulevards and avenues.

"The number of vehicles which pass daily through some of the principal thoroughfares of the city have been ascertained to be as follows: —

"Boulevard de Sebastopol	11,602
Avenue des Champs Elysees	11,734
Rue de Rivoli	13,898
Rue Royale	16,177
Boulevard des Capucines	19,043

"The paved roadways have an aggregate total area of 5,458,000 sq. meters; their maintenance requires the constant service of 431 men (*cantonniers*). The cost per sq. meter varies from 15.90 fr. to 20.40 fr., according to the gage (.10 to .16 meter).

"The cost of hand labor in keeping the pavements in order is 0.154 fr. per sq. meter.

"The macadamized roadways cover an area which, although less than in 1870, is still 1,900,000 sq. meters. The number of *cantonniers* required for their maintenance is 965.

"The steam rollers employed weigh about 30 tons each. The rolling is generally completed in a single night."

See ROAD-ROLLER, "*Mech. Dict.*"

A new pavement, composed of 85 % fine ground granite, and 15% of bitumen, has been laid in Newgate St., London. It is stated to be free from slipperiness, and unaffected by the atmosphere.

It is laid in a heated, semi-fluid condition, 2″ thick, upon a foundation of Portland concrete 9″, thick.

Frusto pyramidal blocks of asphalt are used at Dordrecht, Netherlands.

Abbott	"*Iron Age*," xxi., May 16, p. 5.
Bituminous	"*Scientific Amer.*," xxxvi. 230.
Couzens	"*Scientific American Sup.*," 593.
Foot	"*Scientific American Sup.*," 1297.
French	"*Scientific Amer.*," xxxix. 65.
General Gilmore, on	"*Scientific American Sup.*," 223.
Iron, Hamburg	"*Iron Age*," xx., July 19, p. 24.
Londou	"*Iron Age*," xx., Aug. 23, p. 3.
Pig iron	"*Iron Age*," xvii., April 6, p. 1.
San Francisco	"*Iron Age*," xviii., July 27, p. 7.
Rammer, *Johnson*	* "*Scientific American Sup.*," 326.
	* "*Scientific American*," xli. 235.
Street, "*Inst. Civ. Eng.*"	
Deacon	"*Van Nostrand's Mag.*," xxi. 35.
Wood, *Henson*, Br.	* "*Engineer*," xliii. 251.
	"*Scientific American*," xxxv. 183.
Steam pavior	* "*Scientific American*," xli. 166.
Toronto, Mr. Shanley's report of various systems	"*Scientific American Sup.*," 511.
Washington, D. C., Lieut. Greene's report	"*Evening Star*," Washington, D. C., Oct. 30, 1880.

"*Paving and Roofing Compositions*" is the subject of a volume containing a digest of the United States and British Patents, by *L. W. Sinsabaugh*, Washington, 1875, and a subsequent supplement.

Gen. Q. A. Gillmore's report of Pavements is in Group II., vol. iii., "*Centennial Exhibition Reports*," p. 239, *et seq.*

Gen. Sir J. Burgoyne. "*Road-making, and Maintenance of Macadamized Roads.*"

Gen. Q. A. Gillmore. "*A Practical Treatise on the Construction of Roads, Streets, and Pavements.*"

W. M. Gillespie. "*Manual of the Principles and Practice of Road-making.*"

Pave'ment Pipe. A protection for a gas or water pipe rising to the pavement, or forming a well at the bottom of which is the square of a cock in a water or gas pipe.

Pave'ment Ram'mer. A machine for performing the labor of ramming granite blocks in forming pavement for roadways.

See references on p. 1642, "*Mech. Dict.*," under PAVING MACHINE.

The *Johnson* rammer is shown in Fig. 1885.

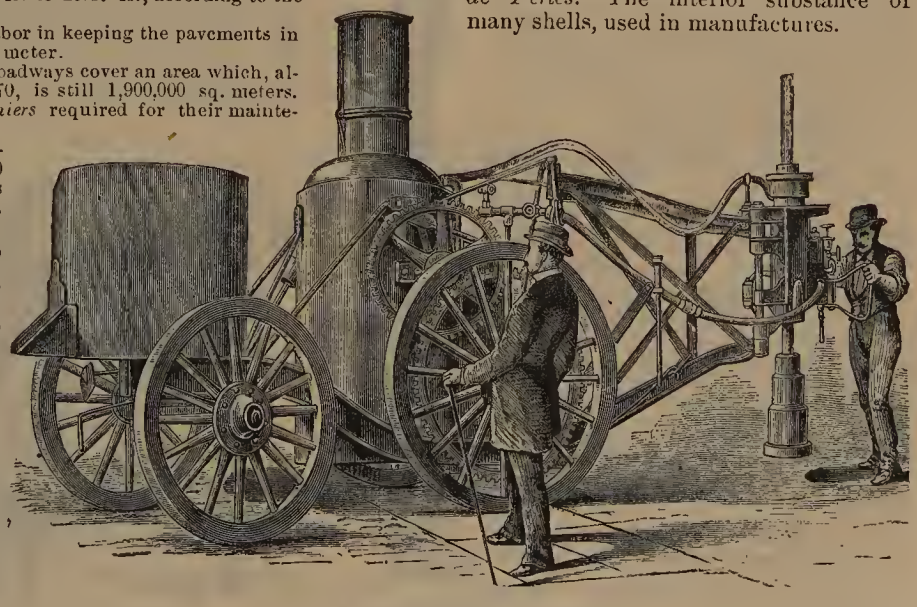
The machine is self-propelling. The crane, which projects forward, carries a steam cylinder containing a reciprocating piston, the rod of which is attached to the rammer. The piston reciprocates in much the same way as a steam hammer, and its movements are controlled by the attendant, who also moves the crane from one side to the other.

Two persons are required to work the machine, which has a power to strike from 1 to 2,200 pounds, at a rate of 160 strokes per minute.

Pav'ing. See PAVEMENT.

Pearl. (*Mother of Pearl.*) Fr. *Nacre de Perles.* The interior substance of many shells, used in manufactures.

Fig. 1885.



Johnson's Power Pavement Rammer.

The pearl oyster, *avicula margaratifera*, of the Indian seas, yields some of the best. It is hard to work, and is cut with fine saws and files, dressed with emery, and polished with calcothar.

The Sanskrit name for a pearl, *maracata*, was conveyed by μαργἄρίτης and *margarita* to the French *marguerite*, the daisy.

David Brewster was the first to explain the irisation of the surface of *nacre*, which is due to the fine ridges, which are more than 3,000 to the inch. This has been proved by taking a cast of the surface, reproducing the delicate inequalities, and producing a similar effect. See PEARL INLAYING; IRIDESCENT GLASS.

Pearls and pearl culture . "*Scientific Amer.*," xl. 170.
Artificial . . . . . "*Scientific Amer. Sup.*," 156.

See also CAMEO CUTTING, p. 156, *supra*.

Pearl'ing. The decortication of barley; stripping the pericarp, except that portion in the crease of the grain, —

"The pearling of barley is accomplished by means of small horizontal mills made of sandstone or wood and having a diameter of about eighteen inches and a thickness of four inches. They revolve at a speed of 400 revolutions per minute, and each of them is enveloped with a covering of sheet iron which is punched with holes like a grater, with the edges of the holes turned inward. Between the sides of the mill and those of the sheet iron is a space of about half an inch. On leaving the winnowing machine the grains of barley fall, by means of a hopper, upon the upper surface of the mill, which, by reason of its rotary movement, throws them toward the circumference where they are rubbed alternately between the vertical surfaces of the mill and the covering of sheet iron. By this means they are pearled and are rounded off like balls of marble. The waste escapes without, and when it is seen that the grains are sufficiently rubbed by this action of the mill and its covering, they are made to pass out by a valve and are replaced by a fresh quantity of unpearled grain." — *Rollet.*

Pearl In'lay-ing. The kinds of pearl are: —

White pearl, so called; obtained from the shell of the pearl oyster.

Aurora shell, from the *haliotis*, sea-ear or sea-shell, as it is variously called, and is remarkable for its wrinkled appearance and iris colors.

Green snail shell, which has changeable colors of green, yellow, and pink.

The shells are sawn, ground to thickness on a grindstone, cut to shape with scissors, punches, or dies, or a number of similar shape are made by glueing the films together, sawing them to shape, and then separating them by dissolving the glue.

Pearl inlaying upon metal is scarcely true *inlaying*, as the pieces of *nacre* are varnished to the object and the spaces filled with varnish. This is laid on in several coats, each being dried in the oven. The varnish is then scraped away from the pearl, and the surface leveled with pumice-stone and then polished.

Fig. 1886.

Peat Spade.

Stems of leaves and veins of flowers are traced with varnish, flowers are colored, and gold added by placing leaf on varnished spots.

The whole is then covered with white varnish.

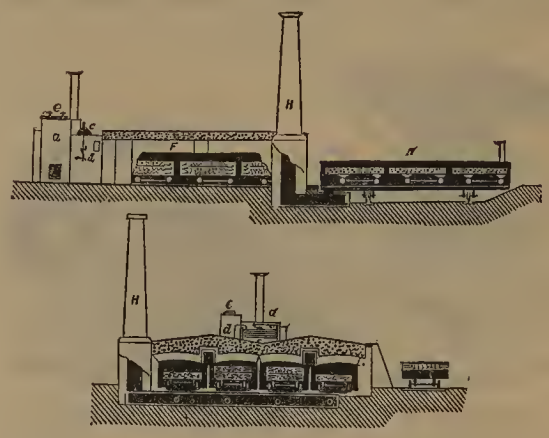
The process with papier-maché is similar.

Peat Char'coal Kiln. A species of oven in which peat in blocks is dried and carbonized.

The ovens are brick arches, covered with sand to retain the heat, and are used in pairs, one being heated while the other is cooling to a sufficient degree to allow the peat to be withdrawn; if air be admitted too soon the peat will inflame. The peat is run into the kiln on trucks, the body being a sort of iron basket with wire netting bottom. The heating is by superheated steam and the heat required to carbonize the peat is 750° Fah. The flues are arranged to allow the diversion of the gases from the furnace when charring has been completed in a given oven. In some cases the peat is dried into blocks: in others it is compressed into *briquets* and dried. The peculiar processes depend upon special conditions.

Peat Spade. One having a side wing at an angle of 90°, so that a cubical prism of peat may be cut from the bank at one thrust.

Fig. 1887.



British Peat Kiln.

Charring app., *Barff*, Br. * "*Engineer*," xlv. 392.
* "*Scientific American Sup.*," 2175.
Condeused, *Britton* . . . "*Iron Age*," xix., April 26, p. 16.
Machine, *Hall & Bainbridge*, Br. . . . . * "*Engineer*," xlii. 344.
Peat steel . . . . . "*Iron Age*," xviii., Nov. 16, p. 11.
"*Scientific Amer. Sup.*," 962, 986.

Leavitt's "Facts about Peat as an Article of Fuel."

Peau d'ours. (*Fabric.*) A Moscow coating made in Germany.

Peb'ble Pow'der. Gunpowder in large grains or masses, comparatively slow-burning. Cube powder; *poudre brutale.*

Pebble powder is usually formed from dense cake $\frac{5}{8}''$ in thickness by breaking it into rectangular prisms and then into cubes, by consecutive operations, the length of the faces being equal to the thickness of the cake. It is also made as large as 11-16″ to 2″ cube.

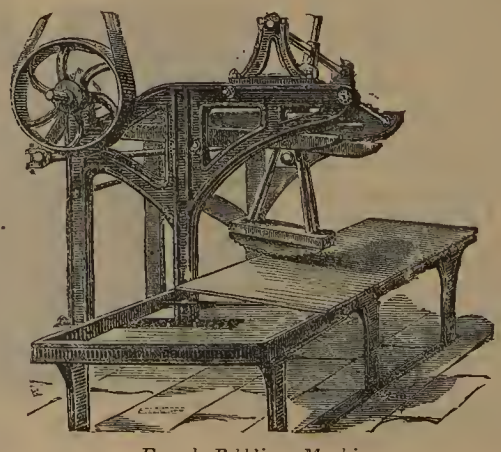
See "*Ordnance Report*," 1879, Appendix I., p. 128, and ENGINEER, September 16, 1870.

Peb'ble Pow'der Ma-chine'. A machine for making cube gunpowder.

The machine is composed of two fluted bronze rollers, each 6″ in diameter, placed about 0.5″ apart, their axes being horizontal and parallel. The teeth formed on the roller by fluting it are 0.5″ apart. The rollers revolve in opposite directions, and the corresponding teeth of the two rollers pass the place joining the axis at the same time. The cake is 14″ × 15″, and is fed vertically between the rollers which break it into right prisms 14″ long with square bases. These fall upon a board, and fed by strips on endless band to a second pair of toothed rollers which break it into cubes.

The result is sifted to remove crushed fragments and dust. The cubes are dusted and are rounded off in the glazing operation, which is done in barrels holding 400 lbs. each. The barrel makes 40 revolutions per minute, and 0.5 oz.

Fig. 1888.



French Pebbling Machine.

black lead is added for each 100 lbs. 40 minutes is required for the operation.

Diagram of pebble-powder machine in "*Report of Chief of Ordnance U. S. A.*," 1877, Plate 1., accompanying Colonel Laidley's report, Appendix K. See also Figs. 70, 71, Appendix L., same report, and p. 546.

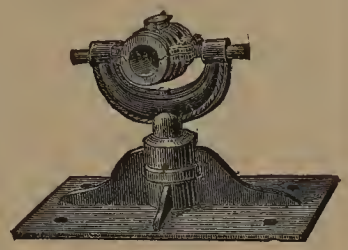
See also Crispin & Baylor's report, "*Ordnance Report*," 1879, App. I., Plate VI., Fig. 13, and description on pp. 128, 1829.

* "*Engineering*" . . . . . xxv. 236.

Peb'bling Ma-chine'. (*Leather.*) A machine in which a pebbling roller is attached to the jack or vibratory arm. The action is known as graining, glassing, glazing, finishing, etc., according to the tool presented.

Ped'es-tal. A ground support for running shafting along a floor or through tunnels.

Fig. 1889.



Shaft Hanger with Ground Pedestal.

(*Add.*) 5. A casting on an abutment to receive the ends of the main brace (or braces) of a bridge and support the strain.

Pe-dom'e-ter. 1. An instrument for counting footsteps. A pace measurer, p. 1647, "*Mech. Dict.*" See also Odometer, *supra*.

* "*Scientific American*" . . . . . xl. 246.

In a modern form it is an instrument looking like a watch, having a dial and a hand; the latter is counter-weighted, so that at each motion of the person in walking, the weight pulsates and the hand advances one degree.

2. A name for roller skates.

Philadelphia Exhibition . . "*Sc. Amer.*," xlii. 99; xl. 85.

Pe'do-mo'tor. A means for the mechanical application of the foot as a driving power.

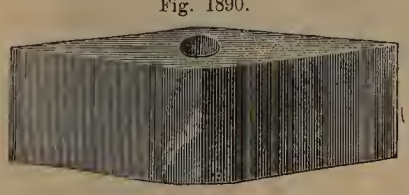
Pedal action for small machines, *Archer*, Br.	* "*Engineer*," xlviii. 344.
Bernays, Br.	* "*Engineer*," xlviii. 438.
Baromotor, *Bozerain* .	*Supra*, p. 76.
Bozerain	* "*Scientific Amer.*," xxxvii. 242.
	* "*Manuf. and Builder*," ix. 280.
Sewing machine motor .	* "*Mech. Dict.*" p. 2123, Fig. 4883.
List of same	*Ibid.*, p. 2115.

Peel. The portion of a cracker or biscuit machine beyond the cutter is known as the *peel-end*, and its capacity gives name to the machine, as *two-peel* machine. See Cracker Machine, etc.

Peel'ing Axe. A double-bitted axe used in barking trees.

Peen Ham'mer. (*Stone Working.*) One which has two opposite cutting edges. It is used for making drafts around the arris or edge of stones and in reducing faces and sometimes joints to a level. Its length is about 10″ and the cutting edge about 4″. It is used after the point and before the patent hammer. See Peen, p. 1647, "*Mech. Dict.*"

Fig. 1890.



Peen Hammer.

Peep Nick'ing Ma-chine'. A special gun tool which forms the peep in the leaf of a rifle sight.

Peep Sight. A form of hind sight for rifles. It has an opening through which the muzzle sight is lined upon the object.

The Open-bead Sight, Fig. 249, p. 84, *supra*, and the Hausse, Fig. 1329, p. 447, *supra*, are instances. See also Globe Sight, Fig. 1210, p. 406, for other instances, and list under Sight.

Peg'ging Ma-chine'. A machine for driving pegs into boot and shoe soles.

Fig. 1891.

Pegging Machine.

The subject has been considered on pp. 1648–1649, Figs. 3602–3606, "*Mech. Dict.*" Fig. 1891 shows a late form of the Varney foot-power pegging machine which operates upon a peg-strip; cutting off the peg, punching a hole, driving the peg, and feeding the boot sole to its place of apposition for the repetitive action.

Pel'let Pow'der. A form of British cannon powder in which each pellet is molded of a given quantity of mealed powder.

Various shapes have been tried: disks, prisms, and cylinders; the latter preferred. The shape is a right cylinder with a circular base and a small hemispherical cavity at one end. Size 0.5″ long, .75″ diameter; weight, 95 grains. The molds are bored holes in a bronze plate in which a gang of bronze pistons work by hydraulic power.

Pebble powder has superseded it, or largely so.

In France the following are the adopted sizes: —

14 centimeter gun from .275″ to .3937″.

19 to 24 centimeter gun from .51″ to .63″.

27 centimeter gun from .63″ to .787″.

See also "*Ordnance Report*," 1879, Appendix I., p. 126, and "*Engineer*," Sept. 16, 1870.

Pel'let-pow'der Ma-chine'. (*Gunpowder.*) A machine in which the powder is compressed into molds of determined shapes.

"*Ordnance Report*," 1879, Appendix I., Plate V., Figs. 11, 12, and described on pp. 126, 127.

Dr. John Anderson's machine for this purpose is shown at Figs. 11, 12, p. 198, vol. xxv., "*Engineering*." See also Pebble Powder.

Pen. Dissertation on pages 1650–1657, with specimens of writing in 105 languages. Plate XXXIX.

Fountain, *Perkins* . .	* "*Scientific American*," xxxv. 98.
Solid ink pen	"*Sc. American*," xxxvii. 112.
Gold pen factory, *Faber*	* "*Scientific American*," xli. 303.
Shading pen	* "*Scientific American*," xlii. 278.

See Fountain Pen; Stylographic Pen.

Pen'cil. History and account of processes, pp. 1656, 1657, "*Mech. Dict.*"

Lead pencils are now made in Germany by rolling paper around the core of graphite to the required thickness.

Paper treated to render Pencil Marks Indelible: Any ordinary drawing paper is slightly warmed and then rapidly and carefully laid on the surface of a bath consisting of a warmed solution of bleached colophonium in alcohol until the entire surface is moistened. It is then dried in a current of hot air. The surface of the paper becomes smooth, but readily takes the impression of a lead pencil. In order to make the lead pencil marks indelible the paper is warmed for a short time on a stove. This method may prove very valuable for the preservation of working drawings when it is not convenient to finish them in ink.

Colored Pencils, Faber's Process.

Black:	Lampblack	10
	White wax	40
	Tallow.	10

White:	Zinc white	40
	White wax	20
	Tallow	10
Light Blue:	Prussian blue	10
	White wax	20
	Tallow	10
Dark Blue:	Prussian blue	15
	Gum Arabic	5
	Tallow	10
Yellow:	Chrome yellow	10
	Wax	20
	Tallow	10

The colors are mixed with the fats in warmed vessels, levigated with the same, and are then allowed to cool until they have acquired the proper consistency for being transferred to the presses. In these the mass is treated and shaped similarly as the graphite in the presses for ordinary pencils.

COPYING.

Walpuski:	Aniline	100
	White clay	50
	Gum tragacanth	10

Alcohol and water to dissolve.

Petit: Aniline.
Graphite.
Chalk.
Gum.
Dextrine.
Water.

Jensen:	Sulph. mercury, Graphite } Optional	10
	Tannic acid	7
	Peroxide iron	2
	Dextrine	1

Or:	Graphite	
	Violet aniline	4
	Dextrine	1

Schwanhauser: Logwood chips, 10, boiled in water: add oxide of chromium till blue color develops; evaporate to sirup; add fatty clay and gum tragacanth.

Indelible:	Wax	1
	Spermaceti	1
	Graphite	2
	Vermilion	1

Heat and grind.

Add:	Nitrate of silver	3

ANOTHER.

Clark:	Glue	2 oz.
	Water	3 oz.
	Nitrate of silver	1 oz.
	Nitric acid	8 drops.
	Lampblack	1 oz.
	Brown sugar	0.25 oz.

ANOTHER.

Pruden:	Alum	4
	Sugar	4
	Gum Arabic	1

Colored . . . . . "*Scientific American*," xli. 298.
Drafting, *McGee* . . . * "*Scientific American*," xxxix. 38.
Early making in U. S. . "*Scientific American Sup.*," 2498.
Indelible . . . . "*Scientific Amer.*," xxxvii. 112.
Lines & colors, fixing . "*Scientific American*," xxxiv. 354.
Manufact. of, *Dixon's* . * "*Scientific American*," xl. 31.
Solid ink pencil, list of patents. "*Scientific Amer.*," xxxvii. 112.

See also ADDING PENCIL; COPYING PENCIL; INK PENCIL.

Pen'dant Tack'le. (*Nautical.*) A tackle rigged from the masthead pendant.

Pen'du-lum. Considered on pp. 1660–1663, "*Mech. Dict.*"

Compensation, *Prof. Smith* . . . . "*Scientific American*," xxxv. 133.
* "*Manufact. & Builder*," x. 204.
Electric controll., *Smith* * "*Engineer*," xlii. 395, 398.
Electro-motor, *Higgs* . * "*Scientific American Sup.*," 913.
Foucault . . . . . * "*Scientific American*," xl. 388.
Toolin . . . . . "*Min. & Sc. Press*," xxxv. 275.
Horizontal, *Zöllners* . . "*Scientific American Sup.*," 1774.
* "*Scientific Amer.*," xxxviii. 79
Redier, Fr. . . . . * "*Scientific American Sup.*," 1163
Pump, *Stannah*, Br. . * "*Engineering*," xxiii 56.
Stannah, Br. . . . * "*Engineer*," xliv. 312.
Regulator, *Jacot* . . . * "*Scientific American*," xxxix. 339
Regulator, Electric . . * "*Scientific American Sup.*," 2435.
Tisley . . . . . * "*Scientific American*," xxxv. 37
Wooden . . . . . "*Scientific American*," xl 310.

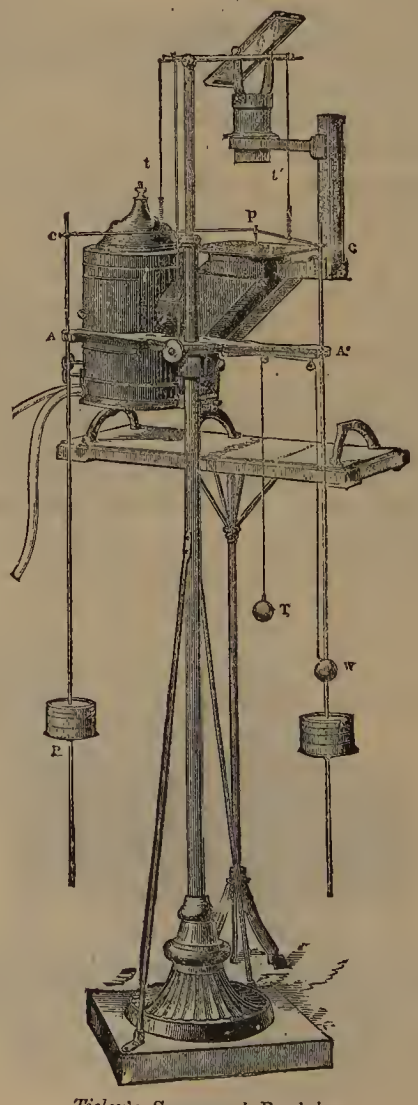
Pen'du-lum In'stru-ment. An instrument for tracing the *Lissajou curves*. In the compound form it is known as *Tisley's* compound pendulum. In the illustration, Fig. 1892, it is shown as adapted to use with the vertical lantern and reflector by which the effects are made visible and projected upon a screen to be viewed by an audience.

Reference has already been made under CURVE INSTRUMENT, p. 236, HARMOGRAPH, p. 439, and LISSAJOU'S CURVES, *supra*, to the instruments for making curves by means of a pen connected with two pendulums swinging in planes at right angles to each other; or a pen to one pendulum and a paper platform to another; also to the mode adopted by M. Lissajou of combining rectangular vibrations to form figures, by means of two tuning-forks carrying small mirrors and vibrating in planes at right angles to each other.

The peculiar curves, the resultants of two vibrations of tuning-forks, produce very instructive diagrams, illustrating definite acoustic relations, such as those corresponding, for example, to the ordinary musical intervals, making the harmonies of sound visible to the eye, and demonstrating visually the relation of the sounds which, united, produce harmonies or discords. — *Lecture of Prof. Bracket, Stevens Institute.*

Under HARMONOGRAPH, p. 439, *supra*, Prof. Tisley's instrument is described. Hopkins has a method of producing the

Fig. 1892.



Tisley's Compound Pendulum.

vibrations by electro-magnet so as to maintain the rate and amplitude of the vibrations, removing the incident of the dying motion of the pendulum without sustaining power.

The compound instrument shown in Fig. 1892 may thus be said to make visible curves representiug the musical intervals, the gradual changes between unison and octave, octave and fifth, etc. The apparatus consists of two pendulums, *P P′*, balanced on knife-edges at *A A′*, and continued above their axis of suspension to *c c′*, from which points project two brass arms, *c p*, *c′ p*, which, when the penduluums are quiescent, meet at right angles, the apex being at *p*. Perfect freedom of motion is secured by conneeting the arms to the pendulum at *c c′* by ball and-socket joints. Two threads, *t t′*, are fasteued at their upper ends to delicate springs, attached to the brass arms, *c p*, *c′ p*, and at their lower euds to an adjustable screw, *d*, by means of which the tracing point *p* may be raised and lowered without in any way affeeting the vibrations of the pendulums.

The brass plates, sliding upon the pendulums, are intended to receive the weights, which can thus be placed at different heights, and the relative rates of vibration of the two penduluuis altered. The sum of the weights used should vary from 5 to 12 lbs. *W* is a weight sliding upon its pendulum, and counterpoised by a weight *T*. The object of *W* is to slightly change the rate of vibration while the pendulums are in motion. By this means the pendulums can be adjusted very accurately, or if desired, one can be given a small fraction of a vibratiou in excess of the other; it ean be entirely removed, if desired.

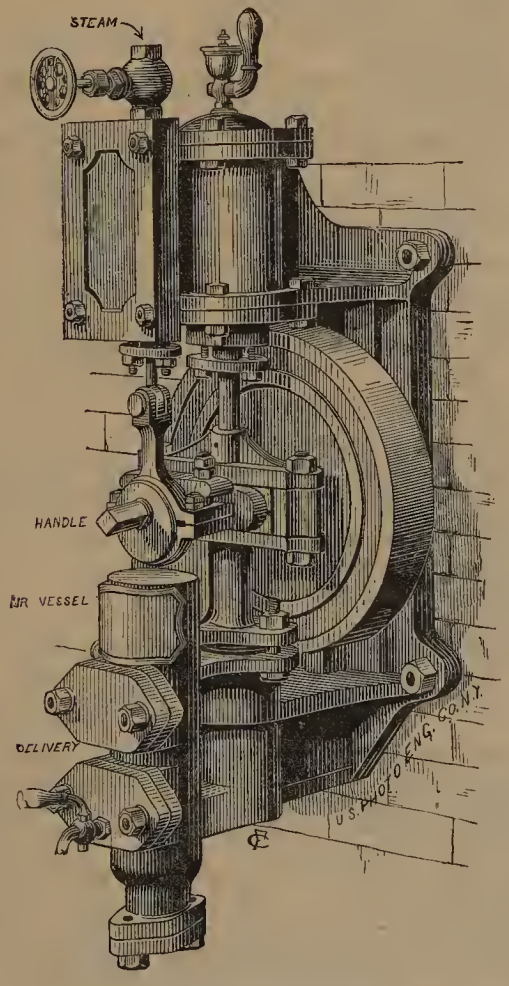
To exhibit these beautiful effects to an audicnce, a plate of glass blackened by burning camphor is placed upon the vertical lantern, as shown in the figure, the requisite weights are added to the pendulums, and these are set in motion.

Then if we want a curve corresponding to an octave, one of the pendulums must make two vibrations while the other makes one. Having ascertained this we start the pendulums together, then lowering the peu, the beautiful curves will be traced.

"It is not easy to imagine a more striking experiment than that afforded in the present instance, by the noiseless and gradually decreasing sweep of a pen-point gliding over its sinuous path, in obedience to the oscillations of two conjoined pendulous bodies, and tracing, before the eyes of admiring spectators curves of maze-like intricacy and yet of faultless symmetry. As in music, the simplest harmony is the most agreeable to the ear, so with these figures, the simpler the proportions between the vibrations of the pendulums, the more pleasing are the resulting curves."

See also Flame Manometer, pp. 344, 580, *supra*.

Fig. 1893.



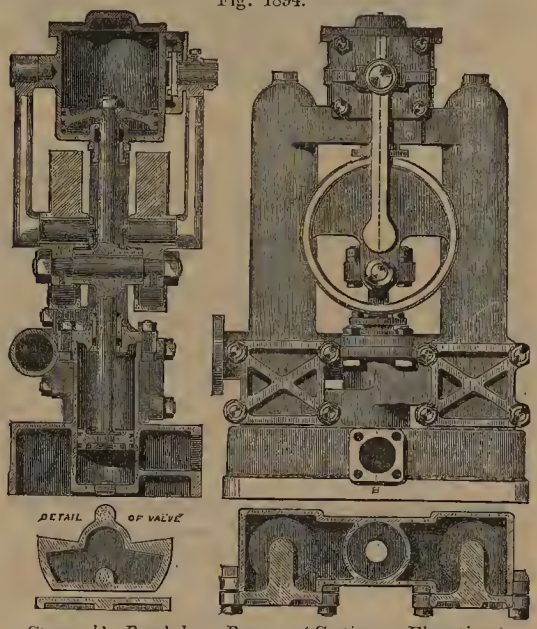
Stannah's Pendulum Pump.

Pen'du-lum Press. A form of press for sheet-metal work, in which the swinging treadle actuates the punch.

Pen'du-lum Pump. 1. A direct acting donkey pump in which the fly-wheels have an oscillatory motion in a vertical plane. Invented by Stannah, London.

The steam and water pistons are fixed on the same rod, and the action is therefore direct. A rotary movement is employed to work the valves and limit the length of the pistons. The remarkable feature about the pump lies in the means adopted for causing the rotation of two fly-wheels, no dog link or connecting rod being employed. The crank-shaft is allowed to move sideways in slots carrying its bearings, and the crank pin is attached direct to a piston rod. In the pendulum pump the two fly-wheels are mounted on pins set in the ends of two hanging links, while a crank pin common to both fly-wheels passes through a suitable bearing in the piston rod. When the pump is at work the fly-wheels oscillate backwards and forwards while revolving, the motion being very moderate in range.

Fig. 1894.



Stannah's Pendulum Pump (Section — Elevation.)

Fig. 1893 shows the pump in perspective, and Fig. 1894 shows it on a smaller scale, in front view and section.

2. A pump the handle of which swings each side of its center of suspension.

Perch. A pole connecting the fore and hind gears of a vehicle. See Reach.

The various irons, etc., are at the points of connection.

Perch plates are *head-blocks* and *bed* plates, above and below the perch at the king-bolt.

Perch iron is a term inclusive of the iron parts generally.

Perch loop; an iron attached to a perch, having loops for the straps which pass to the bed to limit the swinging of the latter.

Perch stays; side rods acting as braces, passing from the perch to the hind axle.

Per-chlo'ride of I'ron Bat'te-ry. (*Electricity.*) Invented by Duchenin.

Zinc in solution of sea-salt, carbon in solution of perchloride of iron.

Niaudet, American translation, 208.

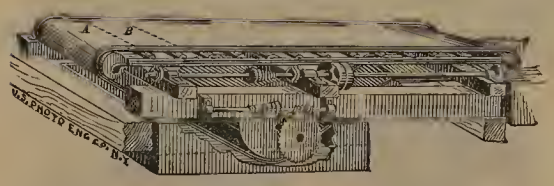
Per-cus'sion Fuse. One which explodes on impact.

The Russian pewter percussion fuse is described on p. 523, and shown in Fig. 17, "*Ordnance Report*," 1877. See also Br., *"*"*Engineer*," xlvii. 79.

Per-cus'sion Ta'ble. (*Ore.*) A device for sorting ores by exposing them to agitation on a slightly inclined traveling apron in a stream of water.

Fruc's percussion table has a rubber belt 2′ broad, constantly shaken from side to side with a regular slow motion.

Fig. 1895.



Concentrating Percussion Table.

This belt is 27′ long, and has projecting flanges of elastic rubber along its outer edges, to keep the sand and water from splashing over. The progressive motion is communicated to the belt by a driving drum, which is connected by a small rubber belt to the front-end roller. The driving drum dips into a tank of water through which the endless apron travels in passing around. On leaving the water tank the belt passes over the tightener and guiding roller.

The ore sized, where the waste is present in larger size than the valuable material, being shaken with a small amount of water will divide evenly on the inclined plane, and the heavier and smaller ore particles will resist the down-flowing water sufficiently to be carried along by the belt over the upper edge into the water tank below; and the waste (lighter and larger particles) will pass over the lower edge. It is successful only on material classified in funnel boxes and of the size of one half millimeter or less.

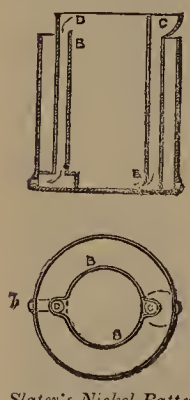
Per-fect'ing Press. A press which prints both sides of the paper at once, or at a single passage. It acts upon a continuous web of paper, and is shown in several figures, pp. 1566–1568, "*Mech. Dict.*"

See also, Printing Press, *infra.*

Per-flu'ent Bat'te-ry. (*Electricity.*) One in which the exciting liquid flows through the cells or cell to keep the battery constant.

In one form of the nickel battery of Slater the exciting fluid

Fig. 1896.



Slater's Nickel Battery.

Fig 1897

Direct-acting Perforator.

is constantly renewed at *C*, passes into the inner cell *B*, overflows at *D*, and issues at *b*.

See also Camacho Battery.

Russell's perfluent battery . "*English Mechanic*," *xxv. 564.

Per'fo-ra'tor. 1. *For Postal Stamps. Cap.* "*Poinçonneuses*," *Laboulaye*, iv.

2. See Rock Drill.

3. (*Telegraphy.*) A machine for perforating slips for the rapid system of telegraph. The letters are represented by holes arrayed in special groups. The perforator has three keys.

Fig. 1898.

Perfume Burner.

Per'fo-ra'ting Ma-chine'. 1. A machine for making the rows of holes which separate the individual postal stamps on a sheet. See p. 1668, "*Mech. Dict.*"

They are *direct-acting* or *rotary*. Fig. 1897 is of the former kind, and the gate carrying the punches is actuated by a treadle.

Per'fume Burn'er. A vase in which perfumes or pastilles are burned.

Perfume bottle, *Ward* . . . *"*"*Sc. Amer.*," xxxvi. 230.
Recipes . . . . . "*Sc. Amer. Sup.*," 1031.

Dussauce's "*Practical Guide for the Perfumer*;" *Pradal, Malepeyre, & Dussauce's* "*Complete Treatise on Perfumery.*"

Pe-ri-ne'um In'stru-ments. (*Surgical.*) For adjusting the parts of and reducing the lacerations of the perineum. They are principally needles, forceps, suture stays.

Ashton's, Skeene's, Agnew's, Peaslee's needles.
Agnew's forceps and adjuster.
Brickell's and *Munson's* stays
Sims' and *Bodenhamer's* forceps.
Suture needles.
Shot compressor.
Pages 115, 116, 123, 124 Part III., *Tiemann's* "*Armam. Chirurgicum.*"

Per'i-os'te-o-tome. (*Surgical.*) A knife for cutting or removing the periosteal membrane.

Sands' and *Sayre's*, p. 8, Part I., *Tiemann's* "*Armam. Chirurgicum.*"
Whitehead's, *Goodwillie's*, p. 66, 57, Part II., *Ibid.*

Per'i-os'te-um Le-va'tor. (*Surgical.*) An instrument for lifting the periosteal membrane; loosening it from the bone.

References to *Tiemann's* "*Armamentarium Chirurgicum.*"
Goodwillie's . . . . . Figs. 70, 71, Part I.
Sands' . . . . . Fig. 37, Part I.
See Fig. 3645, p. 1668, "*Mech. Dict.*"

Pe-riph'e-ry Con'tact Key. A key having two disks, the peripheries of which come in contact to establish the electric connection. See Fig. 847, p. 266, *supra.*

Per'nette. (*Porcelain.*) A little spur or stilt to place between pieces in the kiln.

Also called (Fr.) *Pattes de coq*, or *colifichets*; Eng. *stilts* or *spurs.*

Per'not Fur'nace. An open hearth revolving furnace. See Open Hearth Furnace, *supra.*

Springfield, Ill. . . *"*"*Engineering*," xxix. 374.
""*Amer. Manuf.*," April 25, 1879, p. 8.

Per'not Steel. In each furnace is a pan that can contain 20 tons of steel, which is revolved by a connection with the engine employed for that purpose. After the pan is charged, the gas flames playing over and around it bring the contents to the desired state of fusion, while the revolving of the pan causes the intimate intermixture of the ingredients, thus overcoming the objection to melting steel in larger receptacles than crucibles. The operation is completed in a little more than five hours. See Open Hearth Furnace, *supra.*

Per-ox'ide of Lead Bat'te-ry. (*Electricity.*) An invention of De la Rive.

The negative plate is imbedded in peroxide of lead in the porous jar, the salt acting as a depolarizer. — *Niaudet*, Amer. transl., 179.

Per-ox'ide of Man'ga-nese' Bat'te-ry. (*Electricity.*) One in which peroxide of manganese surrounds the carbon plate and depolarizes the same by oxydizing the hydrogen. The invention of Leclanché. — "*Teleg. Jour.*," iv. 213.

In one of *Gaiffe's* batteries, the positive pole has a carbon cylinder pierced with holes parallel to the axis filled with binoxide of manganese; a zinc rod forms the negative pole. The solution is formed of 20 parts chloride of zinc, free from lead, dissolved in 100 parts of water. — "*Teleg. Jour.*," vi. 185.

Per-spec'to-graph. An instrument for assisting in making perspective projections.

It consists of two fixed rulers, one horizontal and the other vertical, in form like a T-square; a sliding ruler which has a lateral movement right and left along the fixed horizontal member, and a graduated quadraut, which is adjustable up and down the vertical member.

The adjustments and mode of using are described by the inventor in "*Engineering*," * xxii. 223.

Drawing apparatus, *Rosquist* . * "*Sc. Amer.*," xli. 307.
Perspective linead . . . . . "*Man. & Build.*," x. 11.
Perspective ruler . . . . . * "*Sc. Amer. Sup.*," 2506.

Pes E-qui'nus Ap'pa-ra'tus. (*Surgical.*) References under club-foot (*Talipes*) apparatus.

Pe'tra-lite. An explosive: —

Nitrate of potassa	64
Impregnated wood or charcoal	30
Antimonium condenser	6
	100

Pe-tro'le-um. History and application, pp. 1672–1676, "*Mech. Dict.*"

PRODUCTS OF THE DISTILLATION OF CRUDE PETROLEUM.

Gravity, Beaumé.	Name.	Per cent. yielded.	
	Gases.	–	Uncondensed and Lost.
115° B. to 105° B.	Cymogene . .	–	Condensed by pump, for ice machine, boils at 32° F.
105° B. to 95° B.	Rhigolene . .	–	Condensed by ice and salt, used as an anæsthetic, boils at 65° F.
95° B. to 80° B.	Gasoline . . .	1½	Condeused in worm by cold water, used in gas machiues and gas carburetors.
80° B. to 65° B.	Naphtha . . .	10	For *oil cloths*, cleaning, etc.; cleaning oil wells; for adulterating kerosene; fraudulent use in so-called "safety oils."
65° B. to 60° B.	Benzine . . .	4	For paints and varnishes.
60° B. to 38° B.	Kerosene or refined petroleum . . .	55	Ordinary oil for lamps.
38° B. to 25° B.	Paraffine oil .	19½	Semi-solid when cold. Chilled and pressed to separate paraffine; oil used for lubricating.
	Coke, gas, and loss	10	
	Total	100	

Prof. Chandler.
See KEROSENE; PARAFFINE, *supra.*

Petroleum as fuel . . "*Sc. American*," xxxix. 304, 352.
Burner . . . . . "*Scientific American*," xli. 290.
As lubricant in turning, *Rose* . . . . . "*Scientific American*," xxxv. 36.
Burner for locomotives, *Urquhart*, Russia . . * "*Engineering*," xxiii. 9.
Engine . . . . . See HYDRO-CARBON ENGINE, *supra.*
Fire tests . . . . . "*Iron Age*," xxii., Dec. 5, p. 7.
Puddling furnace. *Caldwell* . . . . . * "*Scientific American Sup.*," 125.
Heating furnace. *Ramsden* . . . . . * "*Scientific American Sup.*," 125.
Furnace, *Salisbury* . . "*Scientific American*," xxxix. 336. "*Scientific American Sup.*," 47.

See also LIQUID FUEL FURNACE, *supra.*

Hydro-carbon retort for gas grates, *Holland* . * "*Scientific American*," xliii. 54.
Naphtha, benzine, gasoline . . . . . "*Scientific American*," xxxv. 7.
Storage (cellars) *Donny* * "*Scientific American*," xxxvii. 4.
Stove . . . . . Figs. 3664, 3665, p. 1676, "*Mech. Dict.*"
Tauks . . . . . "*Scientific American*," xxxv. 223. * Fig. 6317, pp. 2536, 2537, "*Mech. Dict.*" * Page 1558, "*Mech. Dict.*"
Tester . . . . . * Fig. 3666, p. 1676, "*Mech. Dict.*" * "*Scientific American*," xliii. 42.
Well, steam in, *Hardison* * "*Scientific American Sup.*," 141.

History, geology, development of the industry and statistics, Brodhead's report in Group I., "*Centennial Reports*," vol. iii., p. 2, *et seq.*

Prof. J. Lawrence Smith's report, *Ibid.*, vol. iv., Group III., p. 121.

Petroleum as fuel, *Ibid.*, p. 161.

Prof. Chandler's report to Board of Health, N. Y.

History, *Prof. J. Sterry Hunt's*, Smithsonian Report, 1861, pp. 319–329.

Pe-tro'le-um Stove. One heated by a coal-oil lamp.

See OIL STOVE, *supra.*
Also PETROLEUM STOVE, Figs. 3664, 3665, p. 1676, "*Mech. Dict.*"

Pe-tro'le-um Test'er. 1. An apparatus to ascertain the flashing point of petroleum oils.

See PETROLEUM TESTER, Fig. 3666, p. 1676, "*Mech. Dict.*"; 6317, 6318, pp. 2536, 2537, *Ibid.*
See also OIL TEST, p. 1558, *Ibid.*
See *Prof. Chandler's* "*Report on Petroleum as an Illuminator*," p. 37, "*Sc. American*," xl. 342.

Mr. Holly modifies the apparatus usually employed by arranging the poles of a battery within ⅜″ from the surface o the oil, so as to pass a spark between them, as the thermometer registers an increase of 1° in temperature. By this meaus the disturbing influences of a flame are avoided.

2. A lubricant tester, which see, *supra.*

Pet'ti-coat Pipe. Shown at Fig. 3667, p. 1676, "*Mech. Dict.*"

Pollock & Wilkinson, Br. * "*Engineer*," xlvi. 57. * "*Railroad Gazette*," viii. 23.

Pew'-gaff. (*Fishing.*) A hook on a staff, used in handling and pitching fish.

Pha'lan-ges Dis'lo-ca'tion Ap'pa-ra'tus. (*Surgical.*) For reducing luxation of the fingers.

Figs. 134–137, Part IV., *Tiemann's* "*Armam. Chirurg.*"

Pha-na'ro-gri-sou'me-ter. An apparatus invented by M. Gossiaux, of Gardanne (Fr.), for indicating the presence of dangerous gases in fiery mines. A lamp of peculiar construction and a pyrometer make up the instrument.

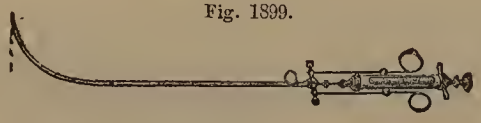
The lamp is covered with a cylinder of wire gauze. A wire spiral encircles this, and extends the eutire length of the cylinder; the wires are held in place by grooves cut in vertical bars forming a frame to the lamp, and are fastened at the top to a ring attached to the cap of the lamp. The wire at the lower end terminates in a tube closed at one end. As the wire dilates under heat, the end of the tube moves a small lever terminating in a sector gearing into a pinion, on which a needle moving on a graduated semicircle is fixed. Constant contact between the end of the lever and the tube is maintained by a small spring, the indicating arrangement being protected by a glass. The heat generated by the pres-

ence of the burning gas in the lamp expands the coil and actuates the needle. To graduate the scale, the lamp is lighted in pure air, and zero is marked when the needle is stationary. A piece of iron, a fifth of the volume of the wire envelope, being brought to a red heat, is placed within the gauze, and as the gauze begins to redden — which represents the condition of the lamp burning in an atmosphere saturated with gas — the position of the needle is marked 100, after which the interval is marked off into a scale of 100 parts.

See also GRISOUMETER; FIRE-DAMP ALARM, *supra*.

Pha-ryn'go-la-ryn'ge-al Syr'inge. An instrument for operating upon the posterior fauces, pharynx, and adjacent parts.

Fig. 1899.



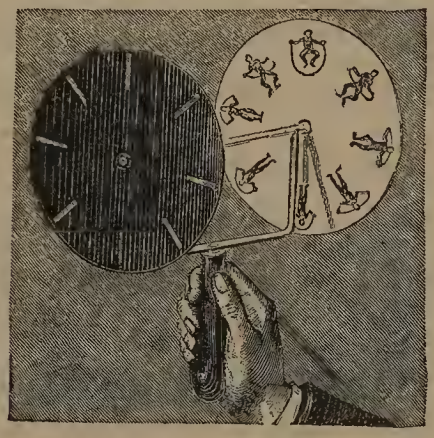
Pharyngo-laryngeal Syringe.

Fig. 1899 shows *Upson's* Pharyngo-laryngeal syringe and aspirator, with flexible hypodermic syringe point.

Phen'a-kis'to-scope. On a disk are painted figures in series representing successive motions; these are viewed in succession as the disk revolves, and give the appearance of motion.

Dr. Roget's phenakistoscope is shown in Fig. 3669, p. 1677,

Fig. 1900.



Plateau's Phenakistoscope.

"*Mech. Dict.*" The Plateau instrument is shown in Fig. 1900. The observer looks through slits in one disk and observes the figures in succession upon the opposite disk. The disks revolve simultaneously.

See PRAXINOSCOPE and references *passim*.

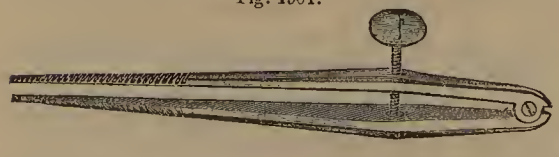
* "*Scientific American Supplement*," 4031.

Phi-mo'sis In'stru-ment. An instrument to excise the inner inelastic mucous membrane of the prepuce without removing the normal skin.

The limbs, or blades, terminate in blunt points, and are deeply serrated on their outer surfaces, with points or teeth set backward, like fine saw-teeth, for the purpose of firmly holding the mucous membrane, without the risk of slipping when traction is made. The blades are forced apart by a thumb-screw.

In operating, the blades, closed to a point, are introduced

Fig. 1901.



Phimosis Instrument.

within the prepuce up beyond the corona of the glans. They are then, by turning the thumb-screw, strongly separated, so as to render the mucous membrane tense. Traction is then made, and the outer elastic skin is drawn back fully, so as to be away from the portion to be excised, and excision is effected by transfixing the prepuce through the middle with the bistoury, and cutting laterally in both directions toward the blades of the instrument.

Phimosis forceps.	Rupturing forceps.
Phimosis scissors.	Circumcision scissors.
Frenum probe and spatula.	

Page 1, Part III., *Tiemann's* "*Armam. Chirurgicum.*"

Phle-bot'o-my In'stru-ments. (*Surgical.*) See CUPPING INSTRUMENTS, *supra*, and p. *659, "*Mech. Dict.*"

LEACH, ARTIFICIAL	* p. 1283, "*Mech. Dict.*"
SCARIFICATOR	* p. 2052, *Ibid.*
LANCET	* p. 1249, *Ibid.*
TRANSFUSION APPARATUS . .	* p. 2613, *Ibid.*

Phœ'nix Stone. An artificial stone, in which the sand is replaced by furnace slag. Made by the Phœnix Stone Co., of Philadelphia.

See *Gen. Q. A. Gillmore's* Report, "*Centennial Exhibition Reports*," *vol. iii., Group II., p. 178.

Phon-ei'do-scope. An instrument for observing the color figures of liquid films under the action of sonorous vibrations.

The instrument invented by Sedley Taylor for showing the action of sound waves upon a film of soap solution contained in a disk laid over a vertical opening in a tube into which articulate sounds are projected.

In one form it is a visible demonstration of the vibratory and molecular motion of a telephone plate. — *S. C. Tisley*, "*Nature*," December 30, 1880.

See also —

"*Engineer*"	* xlv. 421.
"*Manufacturer & Builder*" . . .	xi. 86.
"*Scientific American Sup.*" . .	2041, *2304, 2628.

Phon'ic Ap'par-a'tus. See under the following heads: —

Aërophone.	Phonometer.
Audiometer.	Phonomotor.
Audiphone.	Phonophote.
Autophone.	Phonoscope.
Crown telephone.	Photophone.
Dentiphone.	Receiver.
Dual telephone.	Sphygmophone.
Inductophone.	Stethoscopic microphone.
Magnophone.	Tasimeter.
Megaphone.	Telemicrophone.
Microphone.	Telephone.
Microphone relay.	Telephone call.
Microtasimiter.	Telephonograph.
Microtelephone.	Thermophone.
Motophone.	Topophone.
Phoneidoscope.	Transmitter.
Phonic wheel.	Triple telephone.
Phonograph.	Watch telephone.

Phon'ic Wheel. Apparatus devised by M. Paul de la Cour.

It consists of a toothed wheel of soft iron turning round on an axis, so that the teeth pass very closely to but do not touch the pole of an electro-magnet. If a phono-electro current be caused to pass through the electro-magnet, so that the pole exerts a periodic series of attractions on the tooth nearest to it, then the wheel will be in stable equilibrium when at rest and also when it turns at definite speeds, as when the time of a magnetic impulse is equal to that of the turning of the wheel a distance equal to one tooth. The attraction tends to retard the wheel when it attempts to increase its speed, and to accelerate it when it lags.

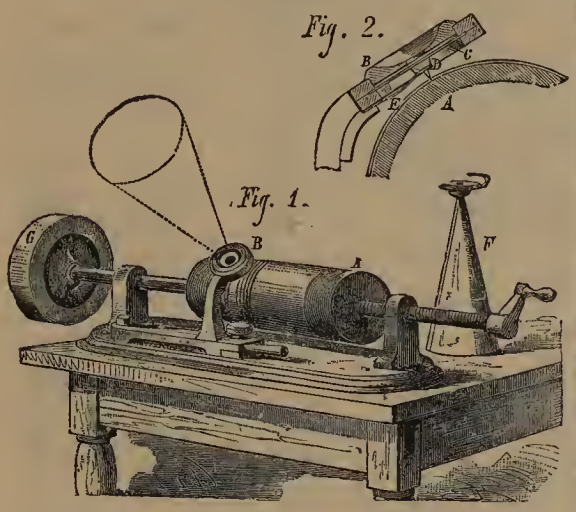
"*Telegraphic Journal*"	* vi. 476.
"*Scientific American Supplement*" . . .	2562.

Pho'no-graph. 1. An apparatus for repeating sound. It consists, as shown in Fig. 1902, of a brass spirally grooved cylinder, *A*, mounted on a long, horizontal screw, the cylinder being rotated, and at the same time, moved laterally by turning a crank on the end of its axis. One diaphragm, *B*, serves the double purpose of vibrating in response to the voice, and so indenting by the diamond-tipped point *D* attached to the spring *E*, the tinfoil wrapped about the cylinder, and also revibrating in response to the movements mechanically imparted to it by

the indentations already made passing under the point.

"The exhibitor sang into the machine an entire verse, and it was repeated as often as the cylinder was readjusted. Sounds of coughing, clearing the throat, knocks, noises of

Fig. 1902.



Edison's Phonograph.

all kinds, were as accurately reproduced. A curious effect is produced by whistling, the apparatus giving forth every note clearly and fully; but more remarkable still is it to hear two voices at once come from the machine. The exhibitor first sang a verse which was registered, and then running the cylinder back talked so that the indentations produced by the speech vibrations came over those made by the song. The instrument repeated both utterances simultaneously, each, however, being clearly distinguishable. Another odd performance is turning the cylinder the wrong way, and making the machine talk the language backward."

A modification of the phonograph is called by Mr. Edison the *airophone*. In this machine the vibrating plate, which in the phonograph moves a sharp point over the revolving cylinder, operates as a valve to shut off and open a flow of steam through the pipe which leads from the boiler to a peculiarly-constructed tube. By this contrivance the steam, instead of producing a discordant whistle, pronounces words with considerable distinctness, and audible at a great distance.

2. A flame manometer which obtains graphic representations of the condition of the human vocal organ. Fig. 1046, p. 344, *supra*.

Phonautograph, *Tyndall*, *Leon Scott* . . . . * "*Scientific Amer.*," xxxvii. 376.
Phonograph, paper by *du Moncel* . . . . "*Technologiste*," xl. 197.
Phipson . . . . . "*Technologiste*," xv. 183.
Preece . . . . . * "*Jour. Soc. Tel. Eng.*," vii. 68.
Phonograph, *Edison* . "*Technologiste*," xl. 123.
* "*Engineer*," xlv. 438.
* "*Engineering*," xxv. 187.
* "*Manuf. & Builder*," x. 84.
* "*Harper's Weekly*," Mar. 30, 1878.
* "*Eng. & Min. Jour.*," xxv. 236.
* "*Harper's Weekly*," Mar. 30, 1878.
"*Iron Age*," xxi., Mar. 28, p. 24.
* "*Scientific American Sup.*," 1893.
* "*Scientific Amer.*," xxxviii. 193.
"*Scientific Amer.*," xxxviii. 86.
"*Scientific American Sup.*," 633.
* "*Teleg. Journal*," vi. 782.
* "*Teleg. Journal*," vi. 6.
* "*Scientific Amer.*," xxxvii. 384.
"*Scientific Amer.*," xxxviii. 405.
Automatic, *Marey & Rosapelly* . . . . * "*Scientific Amer.*," xxxvii. 304.
Exhibition of it . . "*Sc. Amer. Sup.*," 1828, 1904.
Its future, *Edison*. . "*Scientific American Sup.*," 1973.
* "*Engineering*," xxv. 52.
Lambrigot . . . . "*Jour. Soc. Tel. Eng.*," viii. 327.
Preece-Stroh . . . . * "*Engineering*," xxvii. 201.
Koenig . . . . . "*Scientific American Sup.*," 636.
Clock calling the hours, *Edison* . . "*Teleg. Journal*," vi. 142.
Photographing sound "*Man. & Builder*," Feb., 1876.
"*Scientific American Sup.*," 615.
Koenig . . . . . "*Scientific American Sup.*," 636.
Piano . . . . . "*Scientific American*," xxxiv. 111.
* "*Scientific Amer.*," xlii. 6.
Recording sounds of Levy's cornet . . "*Scientific Amer.*," xxxviii. 384.
Sixpenny . . . . . * "*Engineering*," xxvii. 327.
Eng. . . . . * "*Scientific American*," xl. 356.
Working drawings . * "*Scientific American Sup.*," 2112.
Phonophone . . . . "*Manuf. & Builder*," i. 95.

Pho-nom'e-ter. An apparatus designed to assist the signal-man on steamships in marking the intervals of time at which the fog-horn or whistle is to be blown, and to regulate the sounds in such a way as to cause them to announce the ship's course.

It consists of a horizontal clock, placed, face up, in sight of the signal-man. The face is about 8″ in diameter, and indicates seconds only, the minute and hour figures and hands being upon a small dial near one edge. The second-hand has four arms at right angles with each other, and above the face is a movable disk, or dumb card, that obscures about three-fourths of the whole dial. Around the edge of the clock face are painted sections or segments. One of these covers ten seconds' space; four mark five seconds each, and between each are blanks of three seconds each. Outside of the clock is a flat brass ring, having the points of the compass marked upon it.

In using the phonometer, the disk is moved round till the open part comes opposite the ship's head and in line with her course. The segments on the dial that are then visible indicate the number of blasts to be given on the whistle. The second-hands, as they then come into view, give the duration in seconds of each blast and each pause. The signal-man merely watches the hands as they traverse the segments in sight, and sounds his whistle accordingly, announcing the ship's direction. For instance, one blast of ten seconds indicates that the ship is steering within the points north and east, quarter north. Two blasts of five seconds each, with an interval of three seconds between them, would announce the ship's direction as between east and south, quarter east. Three blasts, and two pauses of five and three seconds, would mean south to west, quarter south, while four blasts of five seconds, with the same pauses, would indicate the ship's course to be between west and north, quarter west, and so on. The disk employed is designed to prevent mistakes, and the four hands serve to save time in watching for their appearance and journey over the visible portion of the dial.

Pho-no-mo'tor. The machine has a diaphragm and mouth-piece similar to a phonograph. A spring which is secured to the bed-piece rests on a piece of rubber tubing placed against the diaphragm. This spring carries a pawl that acts on a ratchet or roughened wheel on the fly-wheel shaft. A sound made in the mouth-piece creates vibrations in the diaphragm which are caused to propel a fly-wheel.

"*Scientific American*" . . . . . xxxix. 51.

Pho'no-phone. A term proposed for the phonograph, as the latter term had been previously applied to Scott's machine, which is of different character, and invented many years since.

See PHONAUTOGRAPH, p. 1678, and TELEPHONE, pp. 2514, 2515, "*Mech. Dict.*"

Pho'no-phote. An apparatus for the transformation of sound into light, devised by M. Coulon, Conservator of the Industrial Museum of Rouen.

Two Geissler tubes are put in quick rotation on an axis. The induction coil of the first is worked by an ordinary interrupter, and gives the deviation of a luminous cross. The interrupter of the second is replaced by a telephone. The figure presented by the second tube projects on the first one, which is colored by uranoxide glass, and exhibits the most rapid changes according to the height of the tone delivered in the telephone trumpet. The sensibility of the changes are said to be startling and most interesting. —"*Nature.*"

"*Eng. & Mining Journal*" . . . . . xxviii. 147.

Pho'no-scope. An instrument invented by Henry Edmunds for producing figures of light from vibrations of sound. It consists essentially of three parts, an induction coil, an interrupter, and a re

tary vacuum tube. The action of the instrument is as follows: —

"Sounds from the voice or other sources produce vibrations on the diaphragm of the interrupter, which, being in the primary circuit of the induction coil, induce at each interruption a current in the secondary coil similar to the action of a contact-breaker or rheotome; therefore, each vibration is made visible as a flash in the vacuum tube. This tube revolving all the time at a constant speed, the flashes produce a symmetrical figure like the spokes of a wheel, as in the *Gassiot Star*. The number of spokes or radii is according to the number of vibrations in the interrupter during a revolution of the tube, and the number of vibrations being varied to any extent, according to the sounds produced, the figures in the revolving tube will be varied accordingly. The same sounds always produce the same figures, providing the revolution be constant. In case of rhythmical interruption being produced in a given sound, as in a trill, most beautiful effects are noticeable, owing to the omission of certain radii in regular positions in the figure. The uses of this instrument are the rendering visible of sounds, and showing the vibrations required in their production, and it forms a mode of confirming by sight an appeal to the ear." — *W. Ladd.*

* "*Engineer*" . . . . . xlv. 421.
"*Eng. & Min. Jour.*" . . . . . xxvi. 207.
"*Scientific American Supplement*" . . 2182, 2303.

Phos'phide of Cop'per. See PHOSPHOR BRONZE.

Phos'phor Bronze. Invented by Montefiore & Künzel, the founder of the Val-Benoît nickel manufactory, near Liége.

"Phosphorus bronze is made by fusing phosphorus tin with copper or with phosphorus copper. It fuses at 1230° to 1250°; the finished product usually contains 0.053 to 0.76 per cent. phosphorus and 4 to 9 per cent. tin." — *Dr. Stammer.*

The result of analyses and observations indicates that the phosphorus exercises a double chemical action over the metals which compose the alloys. While reducing on the whole the oxide of tin contained in the mixture, it at the same time forms with the metals it has thus purified a perfectly homogeneous alloy, the hardness and resistance of which are subject to control by varying the proportion of phosphorus.

Experiments have established the superiority of phosphorus alloys over ordinary bronze, copper, coke-iron, charcoal iron, and steel. Under the influence of strains exceeding the limit of elasticity, or of violent shocks, their texture does not become crystalline. They are completely free from metals easily liable to attack, such as zinc. Sea-water, or diluted solutions of sulphuric acid, have only a very feeble action upon them, and in all cases much less than on pure copper. One of their most valuable qualities is, that recasting does not occasion loss in tin. Moreover, their degree of liquidity, which may be compared to that of mercury, renders it possible to obtain them without blisters, and to have perfect moldings. Their degree of fusibility is nearly the same as that of ordinary cannon bronze.

A number of phosphor-bronze alloys are now manufactured, varying in composition to suit the objects for which they are intended. The scope of their application is very great. For instance: —

Bearings.	Locomotive fittings.
Bell metal.	Nails.
Boiler tubes.	Oil cups.
Bolts.	Ornaments.
Buckles.	Printing rollers.
Busts.	Rivets.
Cannon.	Tools.
Cocks.	Tubes.
Engraving plates.	Tuyeres.
Fire-arms.	Valves.
Gun fittings.	Wire.
Hammers.	Wire rope.
Harness fittings.	Wrenches.
Keys.	Etc.
Locks.	

The great features of phosphor-bronze are that it can be made to any degree of hardness, toughness, or elasticity. It can be rendered more ductile than copper, as tough as wrought iron, or as hard as steel. It possesses great fluidity, its homogeneity is complete, and its grain is as fine as that of cast steel. It may be controlled with ease and accuracy to suit the particular purpose for which it is intended, and can be remelted as often as may be desired without any appreciable loss or material alteration of its quality. The phosphor-bronze alloy made for rolling, drawing, or embossing, will stretch more than copper or any of its ordinary compounds. Plates have been reduced by a single cold rolling to one fifth of their thickness, the edge remaining perfectly sound, and without cracks.

The following shows the results of tests made by Mr. David Kirkaldy, of London: —

Cast Metal.	Diminution of Section before Rupture.	Resistance in pounds per square inch.	
		Elastic.	Absolute.
	Per Cent.	*Pounds.*	*Pounds.*
Pure copper . . .	3.30	4,400	6,975
Ordinary gun metal, containing 9 parts copper, 1 part tin .	3.60	12,800	16,650
Phosphor-bronze . .	8.40	23,800	52,625
Phosphor-bronze . .	1.50	24,700	46,100
Phosphor-bronze . .	33.40	16,100	44,448

Drawn Metal.	Pulling Stress per Square Inch.		Twist in 5 Inches.		Ultimate Extension.
	Wire as drawn.	Annealed.	Wire as drawn.	Annealed.	
	lbs.	*lbs.*	*lbs.*	*lbs.*	*Per Cent.*
Various Alloys. Phosphor-Bronze	102,759	49,351	6.7	89	37.5
" "	120,957	47,787	22.3	52	34.1
" "	120,953	53,381	13.0	124	42.4
" "	139,141	54,111	17.3	53	44.9
" "	159,515	58,853	13 3	66	46.6
" "	151,119	64,569	15.8	60	42.8
Copper	63,122	37,002	86.7	96	34.1
Steel	120,976	74,637	22.4	79	10.9
Iron, Galvanized best Charcoal E . . .	65,834	46,160	48.0	87	28.0

N. B. — The wire used for these experiments was No. 16, Birmingham wire gage.

"The following analyses of specimens of phosphor-bronzes show that phosphorus enters into them in very small proportion, though it has a most useful effect: —

Copper . .	93.68	94.11	90.86	94.71	90.34
Tin . . .	5.82	5.15	8.56	4.38	8.99
Phosphorus .	.17	.21	.19	.55	.76
Zinc . . .	.34	.23	–	–	–

"Phosphorus may be introduced directly into the alloy in a state of fusion. In this case a great part of it is lost; only a small quantity combines chemically with the metal. The copper may also be melted in a crucible, lined inside with bone-ash, nitric acid, and charcoal. This mixture should surround the copper on all sides before the closing of the crucible." — *Revue Industrielle.*

See also the following United States patents: —

118,372 *Lavroff*, Phosphor bronze.
115,220 *Levi & Künzell*, Phosphorized bronze.
120,984 *Levi & Künzell*, Phosphorized bronze.
125,549 *Dick*, Phosphorized bronze.
130,702 *Dick*, Phosphor bronze for telegraph wire.
209,240 *Duplaine.*

Copper	100
Nickel	100
Arsenic	3
Phosphorus	3

228,615 *Dick*, Wrought iron, tin, phosphorus; lead, optional.

The subject is considered on p. 1678, "*Mech. Dict.*," where a table is given showing phosphor bronzes from Parke, 1848, to Lavroff and Levi & Künzell, 1871.

The subject may be pursued by refereuce to the following: —

Wire . . . . . "*Scientific American*," xxxvii. 267; xxxix. 71, 409.
"*Sc. Amer. Sup.*," 91, 718, 756.
"*Sc. Am. Sup.*," 283, 1250, 786, 796.
"*Iron Age*," xvii., Feb. 10, p. 23; March 23, p. 20.

Applications . . . . "*Iron Age*," xix., May 24, p 16.
Wire ropes . . . . . "*Iron Age*," xx., July 12, p. 9; xxi., May 9, p. 14; May 16, p. 15.
"*Engineering*," xxiii. 346.
"*Van Nostrand's Eng. Mag.*," xvi 572; xvii. 48.
"*Manufact. & Builder*," viii. 167.
"*Am. Man & Iron World*," xxvi., April 23, p. 11.
"*Eng. & Min. Journal*," xxi. 293; xxii. 44; xxiii. 62, 378; xxvi. 257, 276; xxix. 317, 391.
At Centennial . . "*Eng. & Min. Journal*," xxiii. 14.
"*Min. & Sc. Press*," xxxii. 99, 243; xxxv. 195; xxxvi 19.
"*Teleg. Journal*," vi. 86.
"*English Mechanic*," xxiii. 62, 467; xxiv. 325, 352; xxvi 173, 431.
"*Engineer*," xlii. 26, 393, 431, 466; xliii. 8, 43, 59, 310; xlvii. 26.

Phos'phor Cop'per. An alloy used in the making of phosphor bronze.

"Phosphorus copper may be made by heating together four parts acid calcium phosphate, two of granulated copper, and one part of charcoal; the copper must be pure." — *Dr. Stammer.*

"A crucible is fettled with a mixture of bone ash, silicic acid, and carbon, granulated copper is laid in and covered with a quantity of the fettling mixture, and the whole is fastened down with a cemented cover. Soda and glass can be added to promote fusion. At a fusing heat, the silicic acid acts on the phosphate, the phosphoric acid is reduced and taken up as freed by the copper." — *Dr. Schwarz.*

Phos'pho-res'cent Di'al. Usually made of paper or thin cardboard enameled like visiting cards; covered with an adhesive varnish, or white wax mixed with a little turpentine, over which is dusted with a fine sieve powdered sulphide of barium. Sulphides of strontium and calcium possess the property in a lower degree. The dial loses its phosphorescence after a while in darkness, but is restored by sunlight or burning magnesium wire.

Phosphorescent time-piece "*Sc. American*," xxxix. 339.
Phosphorescent bodies . . "*Sc. American Sup.*," 3887.
Phosphorus manufactory "*Sc. American Sup.*," 2790.
Dial, illuminated . . . p. 254, *supra.*
Illuminated sign . . . p. 489, *Ibid.*

Phos'pho-res'cent Pho'to-graph. A plate coated with a mixture of dextrine, honey, and bichromate of potash is exposed under a negative, the result being that those portions which are exposed to the effect of the light through the transparent portions of the negative harden, while those which are protected from the light remain adhesive. The lines of the image retain any fine powder which is dusted over it, while the hard portions will not retain it. A phosphorescent powder — for instance — sulphite of lime, is dusted over the positive, and, after having been exposed to sunlight, or any strong artificial light, becomes luminous in the dark.

Phos'phor Tin. By heating 6 parts phosphorus with 94 parts moist tin sponge prepared from the chloride by reduction with zinc, the substance formed is $Sn_9 P$, fusible at 370° C.

Made at Graupen tin works at Mariaschein, in Bohemia.

Useful in making phosphor bronze, as it removes the oxides, which tend to harden the latter. See —

"*Iron Age*" . . . . . xx., Nov. 8, p. 15.
"*Engineering & Min. Jour.*" . . . xxiii. 62; xxiv. 70.
"*Am. Manuf. & Iron World*" . . xxvi., Aug. 13, p. 13.
"*Scientific American*" . . . . . xl. 118.

Phos'pho-rus Steel. *Metallurgy.* The invention of Tessie du Motay; the steel contains carbon, 0.12; phosphorus, 0.25; manganese, 0.75.

A. L. Holley . . . "*Iron Age*," xxii., Aug. 29, p. 7.
"*Eng. & Min. Jour.*," xxvi. 217.

Phos'phor Zinc. Zinc with an addition of phosphorus. The combination is, however, much more frequent with the bronze. See PHOSPHOR BRONZE.

Pho'to-col'lo-graph. A photograph in natural colors.

On methods of obtaining natural colors in the camera, from London, "*Photographic News.*"

Captain Abney's process considered. Reference to *Niépce* and *Becquerel.*

Albert's (Munich) process for printing photocollographs. — "*Scientific American*," xli 260.

Pho'to-col'lo-type. A photograph printed in natural colors.

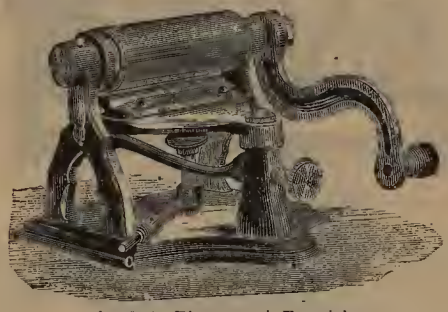
Herr Albert's method . "*Scientific American*," xli. 260.
Mr. Bolas' method . . "*Scientific American Sup.*," 2770.

Pho'to-drome. A scientific instrument for producing optical effects by flashes of light.

It consists of a strong rotator, carrying three disks of devices, each 30″ in diameter, painted on paper; and a small rotator carrying a smaller disk of card-board, with openings in it, to allow the light from a calcium, magnesium, or electric lantern to be thrown upon the first disk by flashes. Each rotator is revolved rapidly, producing curious effects upon the large disk. See PHENAKISTOSCOPE.

Pho'to-graph Bur'nish-er. A little machine in which a brilliant surface is given to a photograph by passing it under pressure over the surface of a burnishing tool. The feeding roller is slightly roughened; the picture is fed, face downward over the burnisher, which is heated by an alcohol lamp beneath.

Fig. 1903.



Schuyler's Photograph Burnisher.

Ewing . . . . "*Scientific American Supplement*," 809.

Pho'to-graph'ic Ri'fle. A device to take photographs of birds in flight.

Capt. Vassel proposes a small dark rifle chamber of 2.27″ interior diameter, surmounted by a proper level and sight. By means of Muybridge's, Janssen's, or other contrivances for taking instantaneous pictures, he thinks that small views might be easily taken which could be subsequently enlarged. He also proposes a photographic revolver for taking a series of successive attitudes at a single operation — "*La Nature.*"

Pho-tog'ra-phom'e-ter. An automatic apparatus to record the angular position of objects situated around a given point.

The objective is mounted vertically on a circular platform capable of rotating, by means of clock-work, in a horizontal plane.

The picture is formed, not in a vertical plane, as ordinarily, but in a horizontal; the rays, passing in through the objective, are deflected 90°, by means of a reflecting prism so as to fall on the horizontal sensitive surface, which is collodionized glass, and is placed in such a way that its center corresponds with the point at which the center point of the diaphragm would be represented. To prevent a number of confused images superimposed on each other being formed during the rotation of the objective, an opaque screen, having a narrow oblong opening, the medial line of which passes through the axis of rotation, is placed over the whole of the sensitized surface, and revolves along with the objective.

The result of this arrangement is the production on the sensitized plate of images of the different points that lie around the observer; the angles formed by lines joining the

center of the plate, and the different objects being exactly the same as those formed by lines joining the center of the instrument and the objects themselves. The position of the objects thus accurately obtained may be transferred to paper, etc., in the ordinary way.

See also OROHELIOGRAPH, *supra*.

Pho-tog'ra-phon. A complete portable photographic apparatus for field-work.

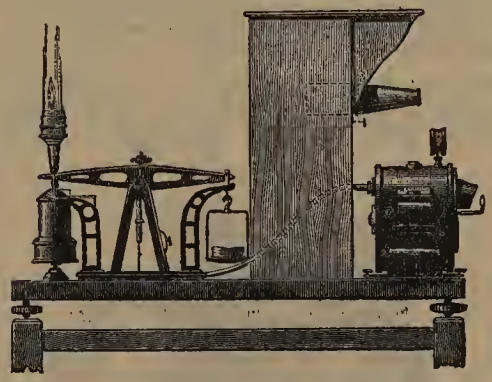
Brice's "English Mechanic" . . . . . xxvii. 141.

Pho-tom'e-ter. A measurer of illuminating power. See instances pp. 1687, 1688, "*Mech. Dict.*"

The official gas-testing apparatus used in the city of Paris is the result of consultations of the *Compagnie Parisienne du Gaz*, and *MM. Dumas* and *Regnault*, and is shown in Figs. 1904–1906.

The table has leveling screws. One extremity of the table has a meter with a dial, one hand registering units of 1-20 liter of gas, and the other hand fixable in any position as a

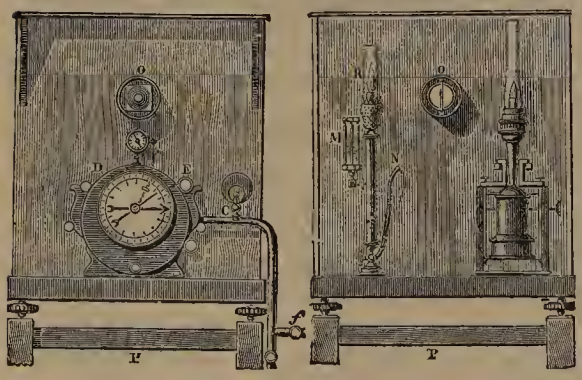
Fig. 1904.



City of Paris Photometer. (*Side Elevation.*)

mark at the commencement of an evaluation, and in connection with the dial-hand of departure is a lever which sets in consentaneous movement the dial-hand of a seconds chronometer placed above the dial of the meter. Behind the meter is a hood beneath which the observer places his

Fig. 1905. Fig. 1906.



City of Paris Photometer. (*Front End View.*) *City of Paris Photometer.* (*Rear End View.*)

head, and looks through the tube which is shown projecting to the right In the tube is placed a glass plate on which is a thin film of starch, and behind this a vertical plate, set edgewise so as to divide the field of view, and allow the light under evaluation and the standard light to be compared.

The chemical photometer of Herr Eden, of Vienna, is based upon the observation that chloride of mercury is very easily reduced to insoluble chloride in sunlight whenever it is mixed with organic substances.

The sensitive solution consists of two volumes of a solution of 40 grams of oxalate of ammonia in one liter of water, and one volume of a solution of 50 grams of sublimate in one liter of water. In sunlight turbidity is immediately produced, the action of the light being weaker as the solution is more dilute. Tables are furnished for the corrections necessary to allow for the influence of increasing dilution and varying temperature on the quantity of the chloride of mercury separated by the photo-chemical process of decomposition.

The pocket photometer of M. Schutte, of Paris, has the form of a small telescope.

Putting the eye to the narrow end and looking through at a light, one sees a small luminous circle, on which is detached some figure in black. On turning the wider part of the instrument, successive numbers are seen, and the higher the number the weaker is the light perceived, and at length it quite disappears. This effect is obtained by means of leaves of waxed paper, the number of which increases with the figures. Thus a weak, luminous source does not allow one to see the same number as a strong one, and the variation between the figures increases with the difference in intensity. The instrument can be used for determining the time of exposure in photography.

The same principle is involved in the actinometer, described on p. 11, "*Mech. Dict.*"

Chemical, *Dr. Eden*, Vienna.
"*Scientific American*," xlii. 137.
Edgerton . . . . . * "*Eng. and Min. Jour.*," xxv. 94.
French . . . . . * *Laboulaye's* "*Dict.*," ii., "*Éclairage.*"
Letheby . . . . . * "*Plumb. & San. Eag.*," ii. 445.
Lighthouse Board, U. S. "*Scientific American Sup.*," 467.
Munzinger . . . . . "*Scientific American Sup.*," 125.
Napoli . . . . . * "*Scientific American Sup.*," 3773.
Phenakistiscope.
Plateau . . . . . * "*Scientific American Sup.*," 4021.

Goodwin's electric photometer extinguishes candle and gas, and stops meter and clock by electricity.

"*American Gas-light Journal*" . . . * July 3, 1876, p. 5.
Goodwin's candle-power jet photometer * *Ibid.*, p. 6.
Portable photometer . . . * *Ibid.*, p. 7.

See JET PHOTOMETER, Fig. 1483, p. 512, *supra*.

Pho'to-met'ric Stan'dard. The *carcel*. A carcel lamp burning 42 grams of refined colza oil per hour, with a flame 40 millimeters high. Equal to { 9.5 British / 7.6 German } standard candles.

"*Popular Science Monthly*" . . October, 1882, p. 864.

Pho'to-phone. An apparatus devised by Alexander Graham Bell and Sumner Tainter for the production and reproduction of sound by means of the undulations of light. Vibrations are conveyed between distantly separated diaphragms by a beam of light.

It is founded upon the sensitiveness of matter to light vibrations, and selenium offers the most promising results of the numerous substances experimented with. Professor Bell's description of one form of the apparatus is as follows: —

"The simplest form of the apparatus for producing the effect . . . . consists of a plane mirror of flexible material, such as silvered mica or microscope glass. Against the back of this mirror the speaker's voice is directed. The light reflected from this mirror is thus thrown into vibrations corresponding to those of the diaphragm itself."

"The beam is received at a distant station upon a parabolic reflector, in the focus of which is placed a sensitive selenium cell, connected in a local circuit with a battery and telephone."

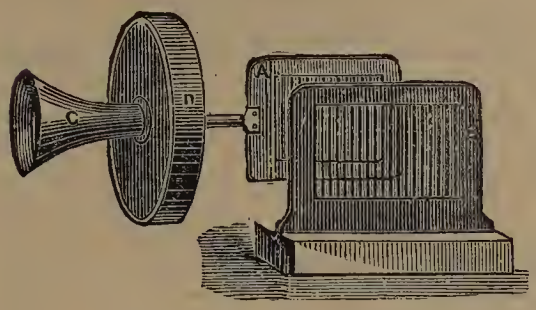
Articulate sentences have been conveyed 213 meters. See address by Professor Bell, at the annual meeting of the "*American Association of Science*," August 25, 1880. Reported in Boston "*Daily Advertiser*" of that period, and reproduced in —

"*Sc. American Supplement*" . p. 3921.
"*Iron Age*" . . . . . xxvi., Dec. 2, p. 1.
"*Manufacturer and Builder*" . . xii. 255.

Fig. 1907 will illustrate an experimental instrument.

"In order to obtain a beam of light, the illuminating intensity of which at a distance could be directly controlled by, and bear a relation to, the sonorous vibrations constituting musical notes or articulate speech, Prof. Bell interposed in the path of a beam of sunlight a screen consisting

Fig. 1907.



Photophone (Illustrative Instrument).

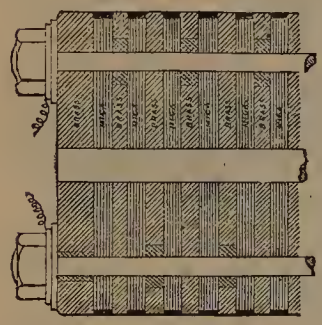
of two thin plates of metal, perforated with a number of fine slits, one of these plates, *B*, being fixed, while the other, *A*, was attached to the center of a diaphragm, *D*, which could be thrown into vibrations by the human voice at *C*, so that the motions of the diaphragm would cause the movable screen to slide backward and forward over the fixed plate, and in so doing alternately enlarge and contract the orifices through which the luminous beam was transmitted."— *Engineering.*

In the illustration the intervals are exaggerated, to render them more clearly visible. "The width of the slits, as well as their distance apart, are so determined with respect to the rigidity of the diaphragm that at no position in the amplitude of the motion is the passage of the beam entirely closed, a certain amount of light passing continuously to the receiver, the opening and contracting of the orifices of the screen merely varying the intensity, for although a rapidly intermittent beam of light would by this means transmit musical notes, it would be powerless to convey even an approximation to the complications of articulate speech."— *Ibid.*

The construction of the selenium cells of the receiver by Messrs. Bell and Tainter is one of the most interesting of the series of ingenious contrivances involved. There is but room here for a sketch of results; the references appended will furnish details omitted here.

Fig. 1908 is the cylindrical form of selenium cell employed by Prof. Bell. The sensitive portion is the cylindrical surface upon which the rays of undulatory light are thrown by a paraboloid reflector in the focus of which it is placed. It consists of a number of circular disks of brass about 2″ in diameter strung upon a rod passing through their common center, and separated by a similar series of disks of mica of slightly smaller diameter. When the compound series is built upon the mandrel a number of grooves occur around the mica, owing to the relatively smaller diameter of its disks. These grooves are filled with melted selenium. The bolts which pass through the disks form the connecting screws for placing the instrument in circuit with a telephone and battery. Every other disk of brass is in connection with the upper bolt, and the alternate disks with the lower bolt.

Fig. 1908.



Bell's Photopile of Receiver.

This alternate connection is shown by the diagram, Fig. 1909, the odd numbered disks being connected by wire *M*

Fig. 1909

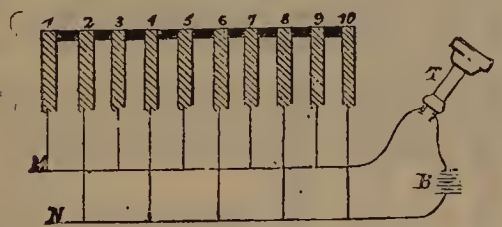


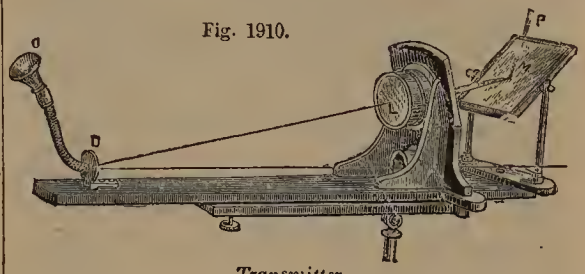
Diagram of Photopile and Connections.

with the telephone *T*, and the even numbered by the wire *N* to the battery *B*, and thence to the telephone *T* in circuit.

Figs. 1910, 1911 illustrate the photophone, the former showing the transmitter, and the latter the receiver.

The transmitting instrument of the photophone (shown in Fig. 1910) consists of a long board, with suitable adjust-

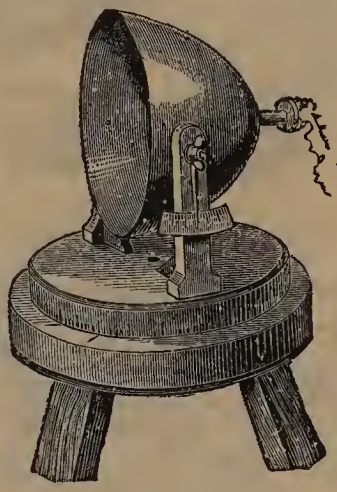
Fig. 1910.



Transmitter.

ments for directing it, within certain limits, in both altitude and azimuth. To the board are attached the various parts of the apparatus. *O* is the mouth-piece, with its reflecting diaphragm, *D*, of silvered glass or mica, and *M* is the mirror by which a ray of light from the sun, or any other powerful source of light, may be projected on to the diaphragm *D* by the condensing lens *L*, below which is fixed another lens, *E*, for the purpose of parallelizing the beam after reflection from the silvered diaphragm, and projecting it to the distant station, where it is received by the paraboloidal reflector of the receiving instrument shown in Fig. 1911, in the focus of which is placed one of the cylindrical

Fig. 1911.



Receiver.

photopiles, Fig. 1908, and in circuit with the latter is placed a pair of telephones and a voltaic battery, which in Professor Bell's experiments consisted of nine Leclanché cells.

The general arrangement and disposition of the whole installation is clearly shown in the diagram, Fig. 1912, in which the portion to the left of the figure is the transmit-

Fig. 1912.

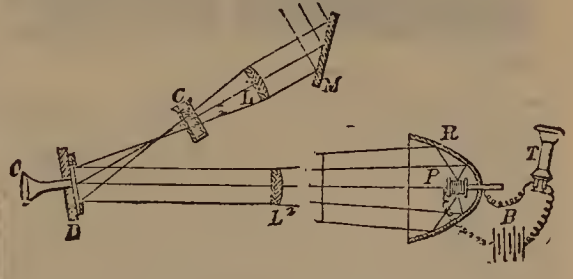


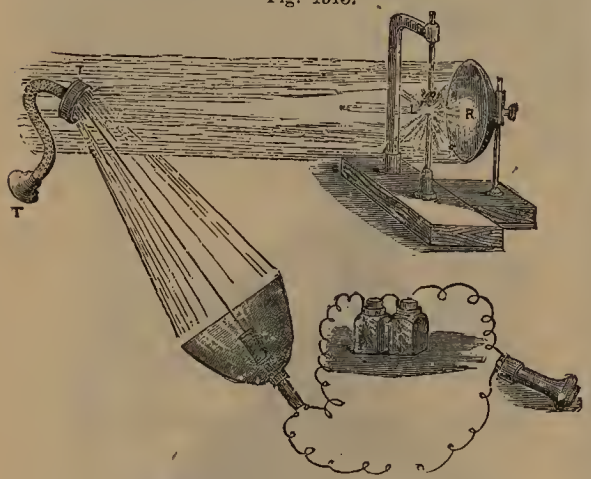
Diagram of Installation.

ting apparatus, and that to the right the receiving instrument. The rays from the sun, or from whatever source of light is employed, after being reflected by the plane mirror *M*, are concentrated upon the face of the reflecting diaphragm *D* by means of the lens *L*, and a small glass trough *C* containing a solution of alum is interposed in their path for the purpose of absorbing the heat rays which, by altering the figure of the diaphragm mirror and introducing other irregularities, might produce disturbing influences which are better eliminated. At L^2 is placed a second lens for the pur-

pose of either parallelizing the rays and projecting them to the receiving apparatus, or of rendering them divergent according to the particular circumstances of the experiment. *R* is the paraboloidal reflector, in the focus of which and coaxial with it is placed the cylindrical photopile *P*, which is included in the circuit of a battery, *B*, and telephone, *T*. When words are spoken into the mouth-piece *O*, the diaphragm *D* is thrown into vibration, becoming thereby alternately more or less convex and concave with continually varying amplitudes of vibration, the effect of which is to confer upon the beam reflected from its surface a continually varying illuminating intensity and, as this undulatory beam is projected by the reflector, *R*, upon every portion of the sensitive surface of the cylindrical photopile, the latter is in the best possible position to produce by its varying electrical resistance the maximum effect in the telephone. —"*Engineering.*"

Fig. 1913 is a diagram showing an apparatus by Prof. Bell, used in Paris in photophonic experiments, with electric light as the source of illumination.

Fig. 1913.

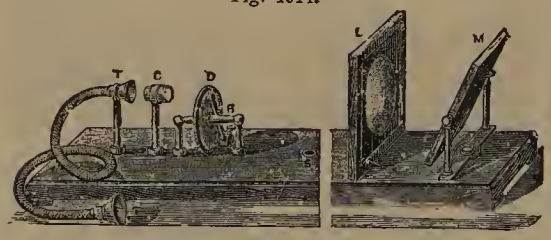


Photophone with Electric Light Illumination.

L is the electric lamp, the arc of which is in the focus of a paraboloidal silvered reflector, *R*, by which the divergent rays emanating from the arc are condensed and projected as a parallel beam to the reflecting diaphragm *T*, by which a certain small proportion of them is reflected to the receiving instrument through a distance of nearly 50′, as shown in the figure.

Fig. 1914 shows an apparatus devised by Messrs. Bell & Tainter in investigating the transmission of sounds from one

Fig. 1914.



Photophone without Electricity.

station to another without the aid of electrical arrangement, or of any thermopile. Almost all substances emit a sound when placed in the path of a beam of soniferous light, such for instance as is reflected from the vibrating diaphragm of the photophone in action, or as is produced by giving to the beam of light a rapidly intermittent character. In the instrument shown in Fig. 1914 rays of solar light are by the lens *L* condensed, after reflection from the surface of the mirror *M*, to a focus on the *D* disk, in which is perforated an annular series of some forty holes, and which can be set into very rapid rotation by arrangements not shown in the figure. By this means a beam of light projected by the lens *L* on to the tube *T* can be interrupted from a hundred to six hundred times in a second, which corresponds to the rapidity of vibration of a musical note of high pitch. When such an intermittent beam is allowed to fall upon diaphragms of different substances placed at the end of the tube *T*, they, with doubtful exceptions, are thrown into vibration, and the corresponding note is heard in the hearing-tube.

When the hearing tube *I* is removed, the apparatus shown in Fig. 1914 may be used as a transmitting instrument for the sending of photophonic signals on the Morse or any other prearranged system to a distant station. In this case, while the disk is in rapid rotation, a shutter operated by a key (shown in the figure) is made either to obstruct the light or to allow it to pass for longer and shorter periods of time corresponding to the dashes or dots in the Morse code. When the instrument is employed for this purpose a plano-convex lens is placed at *C* for parallelizing the beam of intermittent light.

MM. Bell & Tainter have also devised an apparatus for bringing about the variation of the intensity of a luminous beam, by the application of Faraday's discovery of the rotation of the plane of polarization of a beam of light in its passage through a magnetized field. Rays of light emanating from a source of light are parallelized by a lens and projected to a receiving photophone, passing successively through a polarizing Nicols' prism, a hollow coil of insulated wire and an analyzing Nicols' prism. — * "*Engineering*," xxx. 409.

Following in the same line of research is a new apparatus in which a beam of light from a lime light, or even a candle, is thrown upon a common glass flask having a long neck. To this is fastened a rubber speaking tube that may be placed to the ear, so that any sounds in the flask may be heard through the tube.

Between the flask and the light is placed a circular disk of metal, having narrow slots or openings, placed like the spokes of a wheel round the edge. When the disk is at rest, the beam of light may pass through one of the slots and fall on the flask.

If, now, the disk is made to turn rapidly on its axis, the light will reach the flask in a series of flashes, as it shines through the slots one after the other. Here the curious discovery comes in. When the flask is filled with a gas or a vapor, say the vapor of sulphuric ether, common street gas, oxygen, perfumes like patchouli or cassia, or even smoke, and the beam of light is made to fall on the flask in a series of alternate flashes, the operator, listening with the speaking tube at his ear, will hear strange musical sounds inside the flask.

The pitch of these tones will correspond exactly with the speed with which the disk is made to turn, and each kind of gas or vapor in the flask will give a different kind of note, some soft, some loud, and some very sweet and musical.

"This shows that light may be made the means of making sounds audible at a distance, even when the eye can see no difference in the light. It even suggests the idea that we may yet be able to hear the sounds of the fires raging in the sun. It may, indeed, be only a hint to yet more wonderful and unthought of relationships between light and sound, which may be utilized as a medium of communication."

Selenium, on. *Bell* . . "*Engineering*," xxx. 240.
On the photophone . . "*Engineering*," xxx. 253 . * 407.
Lecture and diagram . * "*Engineering*," i. 285.
* "*Manufact. & Builder*," xii. 255.
"*American Manuf.*," Oct. 8, 1880, p. 9.
* "*Scientific American*," xliii. 209.
"*Eng. & Min. Jour.*," xxx. 222.

See discussion by Bell, Latimer-Clark, Tyndall, etc., "*Journal Soc. Telegraph Engineers*," * ix. 263, *et seq.*; 404, *et ssq.*

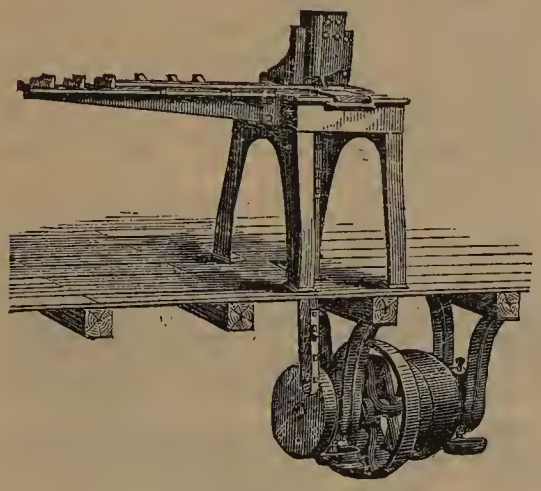
Pho'to-print'ing Pro'cess. Numerous inventions, processes, and modifications are given in the "*Mech. Dict.*," a list being appended on p. 1686. Notices of the following methods may be found in the references cited. There are so many systems, and they anastomose in so intricate a manner, that it is not easy within allowable limits to make even a digest.

In the following list the term printing is used somewhat generally, including relief process, gelatine, and metallic, bichromate or acid processes; also printing from negatives either to make clichés, positive pictures, or transfers.

Name.	Process.	Result.	
Abney, discussion of methods			"*Scientific American Sup.*," 3774.
Bachrach, paper by			"*Scientific American Sup.*," 2195.
Photo-engraving works			* "*Scientific Amer.*," xxxvii. 386.
Asser	photolithograph	print from stone . .	"*Scientific American Sup.*," 1514.
Bowen	wax-ground etching	relief plate . . .	"*Scientific American*," xxxvi. 231.
Cros	photolitho	print from stone . .	"*Scientific American*," xxxvi. 33.
Gobert	bichro. albumen	cliché on glass . .	"*Scientific Amer.*," xxxviii. 117.
	bichro. albumen	cliché on glass . .	"*Scientific American Sup.*," 1891.

Name.	Process.	Result.	
Husnik	photoznico	relief plate	"*Scientific American*," xlii. 404.
	chr. gelatine	glass plate	"*Scientific American*," xxxiv. 386.
	chr. gelatine	glass plate	"*Scientific American*," xxxv. 153.
Jacobsen	gelatine	printing film	"*Scientific American*," xlii. 18.
"*Journal Photography*"	chr. albumen	uczzotint plate	"*Scientific American Sup*," 1177.
Lenoir	albumen	printing film	"*Scientific American*," xliii. 360.
Michaud	chr. gelatine	metal plate	"*Iron Age*," xxii., Aug. 1, p. 9.
Rodreriguez	collodion	silver print	"*Scientific American Sup.*," 1358.
	etching on gelatine and carb. lead	glass negative	"*Scientific American Sup.*," 2194.
	dissolved gelatine	relief block	"*Scientific Amer.*," xxxviii. 26.
	swelled gelatine	relief block	"*Scientific Amer.*," xxxviii. 26.
Vidal	carbon process	film ou artificial stone	"*Scientific American*," xli. 104.
Volkmer	photolithograph		"*Scientific American Sup.*," 3929.
Waterhouse	gelatine	copper plate	"*Scientific American Sup.*," 2276.
	asphaltum	relief	"*Scientific American Sup.*," 2507.
Albert	chr. gelatine cliché	print	"*Mech. Dict.*," 57.
Aubel	fluoric acid ou glass	glass plate	"*Scientific American Sup.*," 1310.
Baldus	asphaltum	copper plate	"*Sc. American Sup.*," 1310, 2509.
Bolas	chr. gelatine	relief block	"*Scientific American Sup.*," 2663.
	photolitho:	stone	"*Scientific American Sup.*," 2276.
	photozinco	relief	"*Scientific American Sup.*," 2276.
	chr. gelatine	cliché	"*Scientific American Sup.*," 2326.
Brand	glass negative	ink print	"*Scientific American*," xxxix. 101.
Despaquis	chr. gelatine cliché	priut	"*Scientific American Sup.*," 1481.
			"*Scientific Amer.*," xxxvii. 74.
Fox-Talbot	bichr. chr. gelatine	print	"*Mech. Dict.*," 1686.
Lichtdruck	bichr.	print	"*Scientific American Sup.*," 1310.
Negre	asphaltum	printing plate	"*Sc. American Sup.*," 1319, 2507.
Niépce	asphaltum	printing plate	"*Scientific American Sup.*," 1310.
Niépce de St Victor	asphaltum	printing plate	"*Mech. Dict.*," 1686.
Poitevin	chr. gelatine	transfer to stone	"*Mech. Dict.*," 1687.
			"*Scientific American*," xli. 395.
Poitevin	chr. gelatine	copper plate	"*Scientific American Sup.*," 1310.
Pretsch	chr. gelatine	copper plate	"*Scientific American Sup.*," 1310.
Scamoni	photo. print	copper plate	"*Sc. Amer. Sup.*," 1310, 1994.
Schahl	chr. gelatine cliché	print	"*Scientific American*," xli. 261.
Warnecke	carb. gelatine	metal plate	"*Scientific American Sup.*," 3775.
Woodbury	chr. gelatine	metal plate	"*Scientific American Sup.*," 1310.
	silver print	print on wooden block	"*Scientific American*," xxxiv. 361.
Woolwich	photolitho:		"*Scientific American Sup.*," 4092.

Fig. 1915.



Picket-heading Machine.

Phy-mo'sis For'ceps. See PHIMOSIS INSTRUMENT.

Phys'i-cal Ap'pa-ra'tus. See EXERCISING MACHINE; HEALTH LIFT; and references *passim*.

Hopkins' simple physical apparatus, *"*Sc. Am.*," xl. 35.

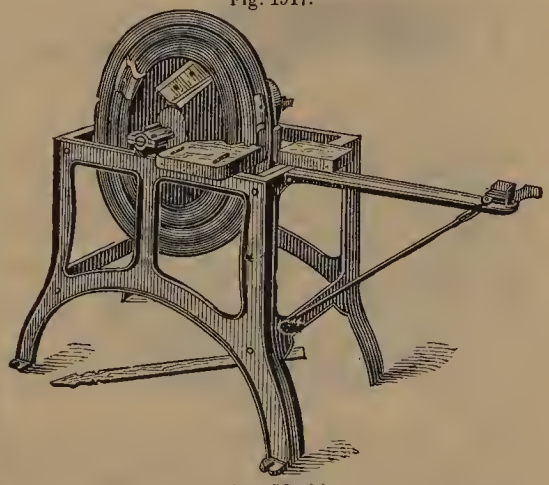
Pick'et Ma-chine'. A machine for making fence pickets.

Fig. 1915 is *Snyder's* picket-heading machine. Its action is a planing motion, the cutter being drawn down by the pitman, operated by a shaft beneath the floor. It cuts heads such as those shown in Fig. 1916. On the arm is a series of checks which are thrown back in a moment to change the length of picket or paling from 5′ to 2.5′ or any intermediate length.

Fig. 1916.

Picket Heads.

Fig. 1917.



Picket-heading Machine.

Fig. 1917 is another style of picket header, the cutters being on a revolving wheel.

Fig. 1916 shows four styles of picket heads.

Pick'et Pin. A pin to which an animal is tied by a lariat.

Fig. 1918 shows one with swivel link on a sleeve; to prevent kinking, and allow the animal to graze around the pin without winding up the lariat.

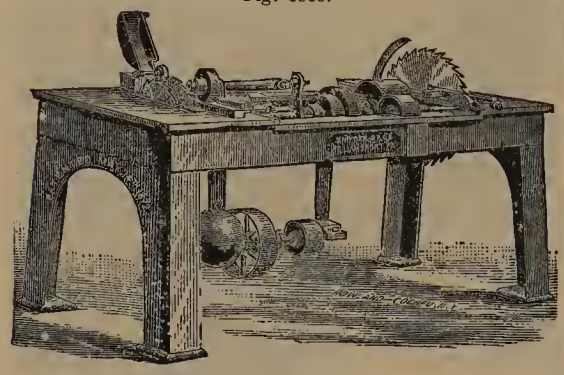
Pick'et-saw'ing Ma-chine'. One for sawing pickets or palings from the bolt.

Zierden's iron-frame gang, lath, and picket sawing machine is shown in Fig. 1919. The illustration shows the cowl or iron cover thrown back. This, when in use, covers and protects the gang of saws, and prevents sawdust being scattered over the mill.

Fig. 1918.

Picket Pin.

Fig. 1919.



Picket-sawing Machine.

Pick Ham'mer. A miner's tool, which has hammer and pick at the respective ends.

Fig. 1920.

Pick Hammer

Pick Mat'tock. One with a blade at one end transverse to the line of the handle, and a point at the other end.

Fig. 1921.

Pick Mattock.

Differs from an *axe mattock*, a simple *mattock*, a *pick*, or a *pick hammer*.

Pic'no-hy-drom'e-ter. A combination of the picnometer and hydrometer. — *Wiegand.*

Described in * "*Scientific American*," xxxiv. 340.

Pic'nom'e-ter. A specific gravity glass.

Pic'ture Lens. (*Optics.*) A large, double convex lens of very long focus, and mounted in a hand-frame; for examining pictures or paintings when hung upon a wall. See also CLAUDE LORRAINE.

Pier. The subject is considered under various heads in the "*Mech. Dict.*" AIR LOCK, Plate II., p. 49; PIER, p. 1699, etc. See list under HYDRAULIC ENGINEERING, pp. 1129–1148, *Ibid.*

See: Promenade, Aldborough, Br. . . .	* "*Engineer*," xlvi. 182.
Ore shipping, Bilboa, Spain	* "*Engineer*," xlviii. 409.
Coney Island	"*Scientific American*," xl. 344.
Staging, E. River Bridge	* "*Engineering*," xxv. 129, 171.
Tidal, Edgerton, Engl. .	* "*Scientific American Sup.*," 898.
Hudson bridge, Poughkeepsie	* "*Trans. Am. Soc. Civ. Eng.*, vii. 336.
Ore shipping, Huelva, Spain	* "*Engineer*," xli. 360, 363, 374.
Iron, *Lewes*, Delaware Col. Kurtz	* "*Scientific Am. Sup.*," 1142, 1155.
Iron, Long Branch . .	"*Scientific American*," xl. 161.
Omaha iron piers . . .	* "*Trans. Am. So. Civ. Eng.*," vii 338.
Rio Tinto Ry., Spain .	"*Scientific Am. Sup.*," 1971, 2018.
Promenade iron pier. *Skegness*, Br. . . .	* "*Engineer*," xlix. 44, 62.
Withernsea, Br. . . .	* "*Engineer*," xlv. 62.

The report by Major Turnbull on the construction of the piers of the Alexandria canal aqueduct across the Potomac, at Georgetown, D. C. (1838–1841), was reprinted for Engineer Department, U. S. A., 1873. 4to.

Pier'cing. The act of *sawing* a pattern or object out of a plate, in contra-distinction to *punching*. Jig and band saws are used for the purpose.

Pie'som'e-ter. See PIEZOMETER; PRESSURE GAGE; and references *passim*.

Pi'e-zom'e-ter. 1. (*Surgical.*) An instrument to measure the sense of pressure. It consists of a spring in a German silver graduated tube. The spring is pressed by a rod, on the end of which is a hard rubber disk $\frac{1}{3}''$ in diameter.

The sense of pressure is strongest on the forehead, tongue, and cheek; next in order come the fingers, back of hand, forearm, and arm; then the anterior portion of the thigh and leg, back of foot, and toes. The least sensitive portions are the back of thigh and leg.

Beard's Fig. 284, Part I., *Tiemann's* '*Armam. Chirurg.*"

See also ÆSTHESIOMETER.

2. An instrument to ascertain the pressure set up in the bore of a gun when a charge of powder is fired.

"*Engineer*," * Sept. 16, 1870; vol. xlvii., 83, 134, 170.

See "*Ordnance Report*," 1879, Appendix M., pp. 228–256, and Plates I.–XI.

See also CUTTER; CRUSHER GAGE, *supra*; * PRESSURE GAGE, *infra*.

The piezometer of M. Sebert consists of a metallic rod of square section fixed in the axis of a hollow projectile, and which serves as a guide to a movable mass. The latter carries a small tuning fork the prongs of which terminate in two small metallic pens which leave undulating traces of their passage on one of the faces of the rod, which has been coated with lamp black. It is designed to determine the laws of motion of a projectile in the bore of a cannon in order to deduce therefrom the law of the pressures developed by the combustion of the charge.

"*Scientific American*"	xl. 1811.
* "*Scientific American Sup.*"	4042.

3. The same principle is adopted in obtaining measurements of depth in soundiug. In *Thomson's* navigational sounding apparatus, shown and described on pp. 351, 352, *supra*, the observed condensation of air in a tube attached to the sinker and registering itself by the contact of sea water with a preparation lining the tube, is made the measure of depth.

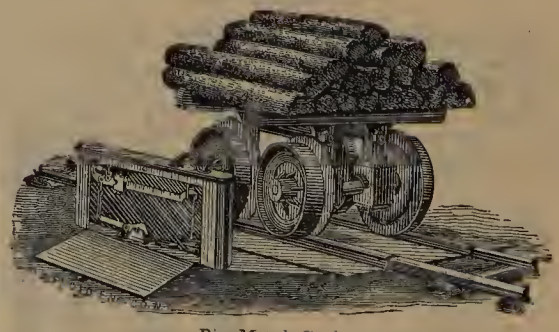
Enchanan . . . . "*Van Nostrand's Mag.*," xviii. 61.

Pig and Ore Pro'cess. (*Metallurgy.*) A process of Dr. C. W. Siemens.

It consists in melting down a charge of pig-iron together with enough iron ore to make good the loss of pig-iron by oxidation. The ore facilitates the decarburization of the pig-iron. The pig and ore process is coming largely into use, and is in Great Britain, where it is well done on a large scale, a successful rival of the Bessemer process. — *Holley.*

Pig Met'al Scales. An iron truck to run on to a section of railway upon scale platform.

Fig. 1922.



Pig Metal Scales.

The car is intended to hold a furnace charge. The beam is concealed, but has an indicator which passes through the top of the beam box.

Pike Pole. A tool used by lumbermen in driving logs in rivers. See Fig. 1923.

Pile Dam. A dam made by driving piles and filling in with stones. It usually has planking to protect the surfaces.

See Pile dam on the Little Kaukanna, Fox River improvements: "*Report of Chief of Engineers U. S. Army*," 1876, vol. ii., part 2, Plate II., p. 416.

Fig. 1923.

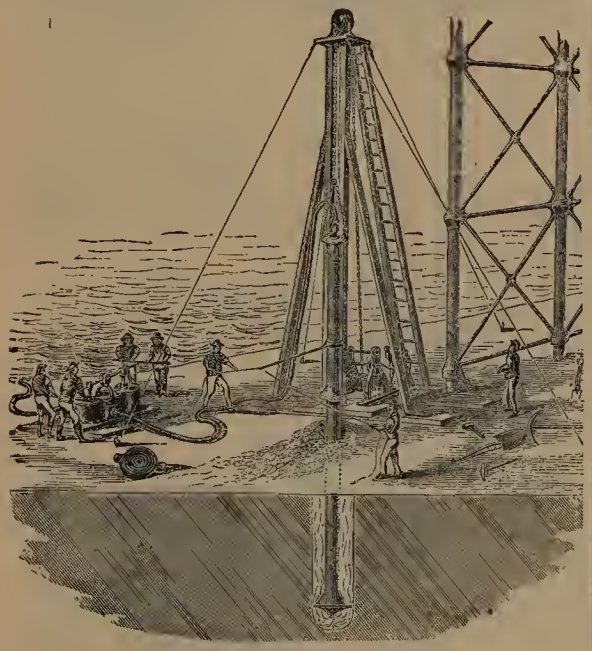
Pike Pole.

Pile Dri'ver. The pile driver as a ramming engine to force piles into the ground is shown in Figs. 3717, 3718, pp. 1702, 1703, "*Mech. Dict.*" See also Pile-driving Engine, *infra*; Pneumatic Pile, "*Mech. Dict.*," *et infra*, and references *passim*.

The method of driving piles by aid of hydraulic jet has been very successful in sands and soils which are free of logs and bowlders. The operation is shown in Fig. 1924. It is a device of British engineers, used at Morecombe Bay in India, in building a railway bridge crossing some treacherous sands and also used in the construction of Southport pier, England. The pile is in hollow iron sections and has a bulbous shoe.

"The columns, 9″ in diameter and of $\frac{3}{4}$″ metal, terminate in an extended base 18″ in diameter, with a contracted opening of $2\frac{1}{2}$″. This disk is provided with toothed edges, and serrated flanges to scratch away any impediments, and cut through the layers of indurated mud and silt which here and there interpose and interrupt its progress. The column is clasped by moving guides on the face of an ordinary piling engine frame, and down the inside

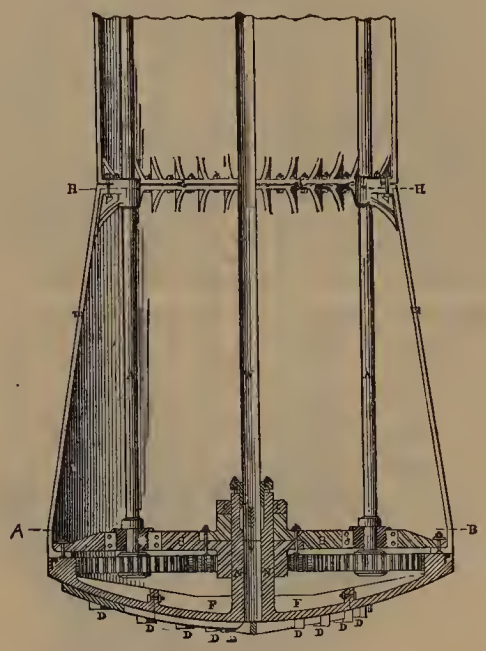
Fig. 1924.



Dickson's Hydraulic Pile Driving

is run an iron tube $2\frac{1}{2}$″ in diameter, protruding a few inches beyond the base. The upper end of this tube being brought round, is attached by screw couplings to a flexible hose, in connection with a steam pump. The whole being duly placed in position, a couple of men are told off to keep the column in reciprocating motion by means of a lever clasped round it, and all being ready the pumps are set to work. The issuing jet of water blows up the sand, which is thus kept continually agitated, and down goes the pile in the hole thus formed, steadily lowered by the men at the winch, the ascending stream keeping the sand above alive, and preventing it setting; but so soon as the requisite depth is attained, the pumps are stopped, and the tube rapidly withdrawn, and the whole in the course of a few minutes is firmly fixed. These columns, in the case cited at Southport, are all put down a depth of 15′ to 20′, the average time occupied in the actual process of sinking being but 20 to 30 minutes. Two or three were fixed in a tide, the bulk of the time being necessarily occupied in moving about the

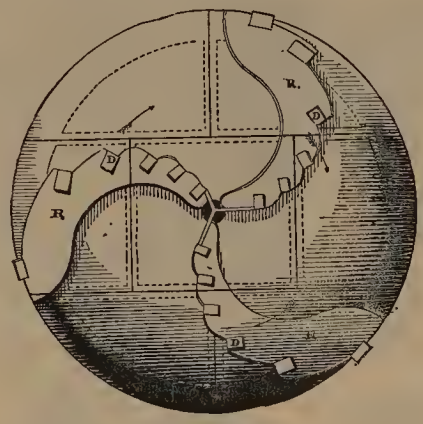
Fig. 1925.



Section through Axis of Pile.

apparatus and machinery. Some of the piles were sunk from a raft, the process answering equally as well under water as ashore. An experimental column with a reduced

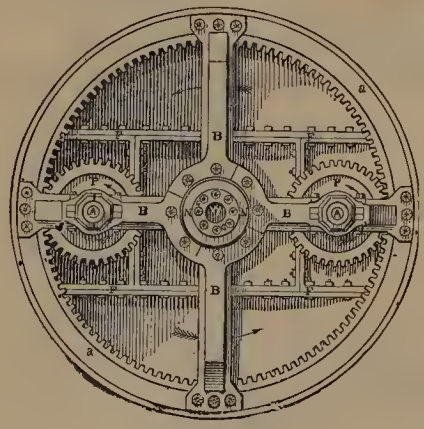
Fig. 1926



Plan of Bottom.

disk, was sunk in less than 20 minutes to a depth of 26′.: — "*Engineer.*"

Fig. 1927.



Section through A-B.
(*Showing Plan of Bridge-piece and Arrangement of Gearing*)

Figs. 1925-1927 show excavating shoes to be added to the end of the ordinary tubular pile when the soil is of such a nature as not to yield to the mere impact of water.

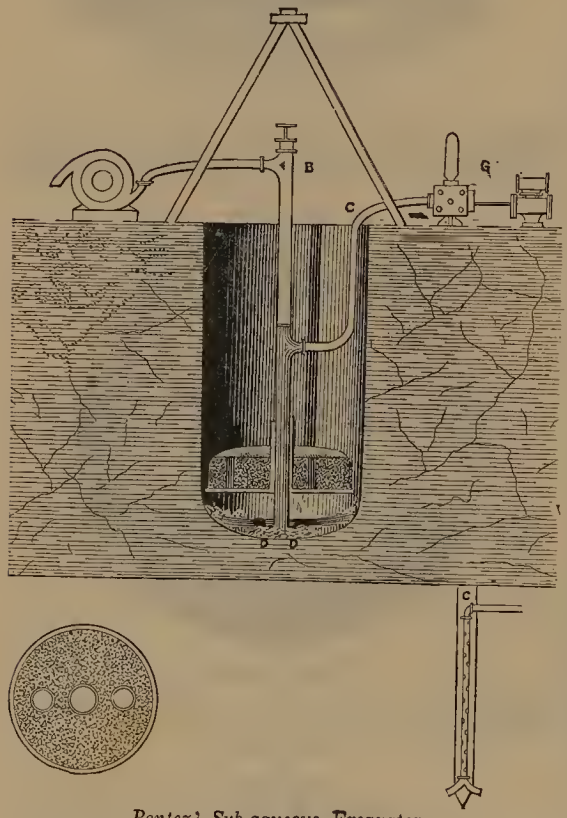
The cylinder itself is not rotated but is held upright over the spot it is to occupy and sinks as the earth is excavated beneath it. The sole of the pile is shown in section in Fig. 1925 and in plan in Fig. 1926, steel cutters *D* being placed on curved blades *R*, and driven by means of gears *P* on shafts *A* supported in sockets *R* and bridge *B*. The gears *P* mesh into an internal cog-wheel *A* which is a part of the sole *F*.

The shoe being rotated comminutes the soil which is driven away by a copious jet of water conducted down the interior of the cylinder. The required depth being reached, an air chamber is attached to the top of the pile and air forced in to empty the pile while the machinery of the bottom portion is all removed. The pile is then filled with concrete.

Pile Dri'ving. The methods of sinking piles and caissons by pneumatic methods or by combined pneumatic and other methods have been considered under *Pneumatic Pile, p. 1754; *Caisson, p. 421; *Air Lock, p. 49; *Submarine Excavator, p. 2439, "*Mech. Dict.*" See also Pile, *supra*.

Figs. 1928–1930 show views of the subaqueous excavator of Pontez, used for driving piles or making solid foundations in quicksands or unstable soils.

Fig. 1928.



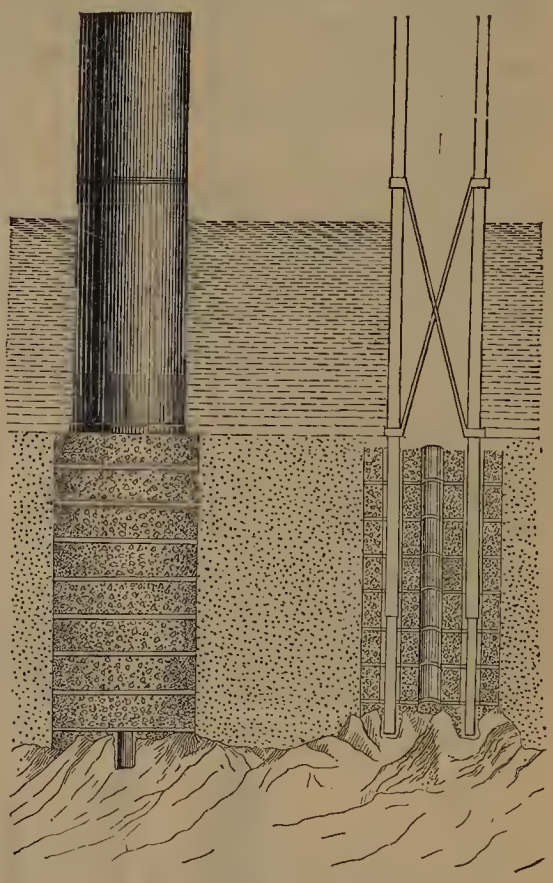
Pontez' Sub-aqueous Excavator.

Fig. 1928 is a vertical section showing the excavating cylinder in position, also the working apparatus. Beneath the view of the apparatus in situ are two detached figures: one a plan of the disk showing the central hole for the tubes, and other holes for piles which are to be driven through. On the right is a sectional elevation of the excavating cylinder, showing internal perforated tube *C*, and hydraulic jets *D D*.

The excavating cylinder *B* is formed of sheet iron, connected at its upper extremity with a powerful suction pump or air-tight receiver. The lower section of the excavator is connected with another pump, a force pump, by the hose *C* which passing through the side of the excavating cylinder, then feeds a pipe perforated with a number of small holes. This pipe, leading down near the open end of the cylinder *B* bifurcates and then projects outside the cylinder at opposite sides, forming two external hydraulic excavating jets *D D*.

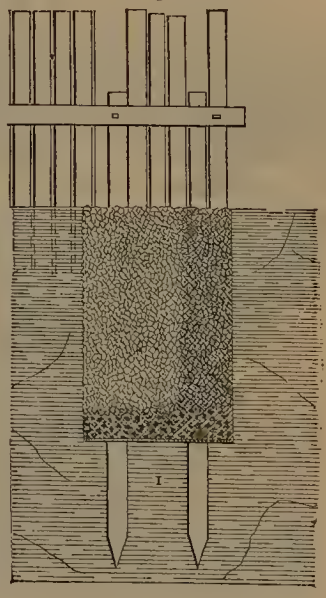
The operation for sinking a disk is as follows: The excavating cylinder is passed through the central aperture, and rests on the mud beneath; the connections are then made respectively with the force-pump and suction-pump or vacuum chamber. The first effect of the action of the suction-pump is to force the nozzle of the excavator, by atmospheric pressure, into the mud for some depth, thereby excluding the outer water. A column of permeable sand or mud now fills the cylinder; under the power of the suction it packs tightly, and the operation would cease, but simultaneously the force-pump *G* sends into the column of mud numerous small jets of water; the moment it becomes permeable it passes on in a continuous flow and is delivered by the pump, holding the maximum of solid matter with the minimum of water, or air if forced in instead of water. The diverging hydraulic or air jets acting over and beyond the area covered by the disk, excavate beneath and undermine it, the material passing into the excavator, the disk subsides. Bowlders or large stones encountered would be washed into the center of the excavation, where they could be broken through the aperture.

Fig. 1929.



Elevation and Section of Pile Foundation.

Fig. 1930.



Sheet Piling.

Fig. 1929 shows two forms of piles sunken by these means. One has a series of disks with intervening concrete or rip-rap. The sectional view shows the disks with central tube, and the side piles in position.

Fig. 1930 shows the plan as adapted to sheet piling.

Cf. Pile, *Le Grand & Sutcliff* . . . . . "*Engineer*," xlvii 183.
Pile-driver . . . . . * "*Engineering*," xxiii. 433.

Pile-driver	"*Scientific Amer.*," xxxviii. 388.
	* "*Scientific American*," xli. 147.
Machinery, *Dresden*	* "*Engineer*," xlii. 372.
Gunpowder, *Shaw*	* "*Engineering*," xxi. 408.
Machine, *Mundy*	* "*Scientific Amer.*," xxxvi. 338.
Engine, *Mundy*	* "*Manufact. & Builder*," ix. 129.
Powder	"*Van Nostrand's Mag.*," 2210.
Steam, *Lewicki*	"*Van Nostrand's Mag.*," 2210.
Water jet, Calais	* "*Scientific American Sup.*," 2050.
Water jet in 1863	"*Scientific Amer.*," xxxviii. 340.
Friction drum hoist	* Fig. 1099, p. 357, *supra.*
Pneumatic process, *Glenn*	"*Sc. Amer. Sup.*," 2238, * 3769.
In sand, water jet, *Pontez*	"*Scientific American*," xxxix. 20.
Explosive, *Vogler*	U. S. Patent, No. 137,514.
Tubular, *Le Grand & Sutcliff*	* "*Engineering*," xxvii. 223.

Janvier, * *Laboulaye's* "*Dict.*," iv., ed. 1877, art. "*Pilotis.*" * *Bower.* * *Nasmyth.*

Austrian steam pile drivers, * "*Vienna Exposition Reports*," iii., Sec. II., p. 56, and Plate XVII.

Sabot de Pilotis, Defontaine	"*Technologiste*," xli. 793.
Driving by hyd. pressure, *Wieck*	"*Technologiste*," xli. 206.
Driving by dynamite	"*Technologiste*," xl. 64.

Pile-dri'ving En'gine. An engine specially adapted for the working of the pile driving by monkey, and the lifting of piles into position for driving.

The lifting gear is single purchase, and is usually proportioned for working with a monkey not exceeding one ton in weight. The barrel is loose on the shaft, and is made fast to it by a powerful conical friction clutch, which is thrown in and out of contact with the barrel by the hand-lever; this lever is also connected by a rod to the throttle-valve, which automatically regulates the supply of steam

The capstan-end is used for pitching piles or for hauling; the strap-brake is worked by the foot-lever, and is used for holding the load, or for preventing the chain from overhauling too much.

See FRICTION DRUM HOIST, Fig. 1099, p. 357, *supra*. Also Figs. 454 and 1359.

Pile In'stru-ments. (*Surgical.*) See "HEMORRHOIDAL INSTRUMENTS."

Pile Tel'e-phone. A telephone having a voltaic pile in the circuit.

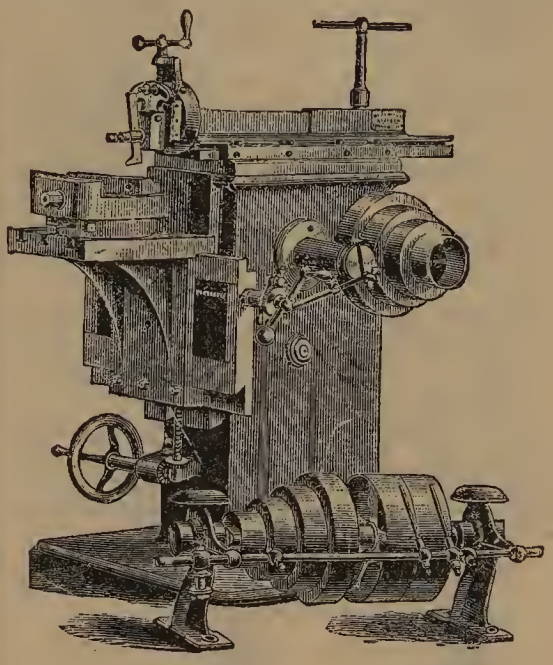
In *Edison's* a piece of cork is fastened to the diaphragm and presses upon a strip of platinum, which is attached to a plate of copper; the latter is one of the terminals of an ordinary galvanic pile.

* "*Scientific American Supplement*"	2591–2594.
* "*Engineer*"	xlvi. p. 425.

Pil'lar Dril'ling Ma-chine'. A machine tool which stands erect upon a pillar support on which the bench or platform is adjustable vertically by rack and pinion. The machine shown has treble speeds by means of sets of gearing.

Pil'lar Sha'per. A compact form of planing machine for metal.

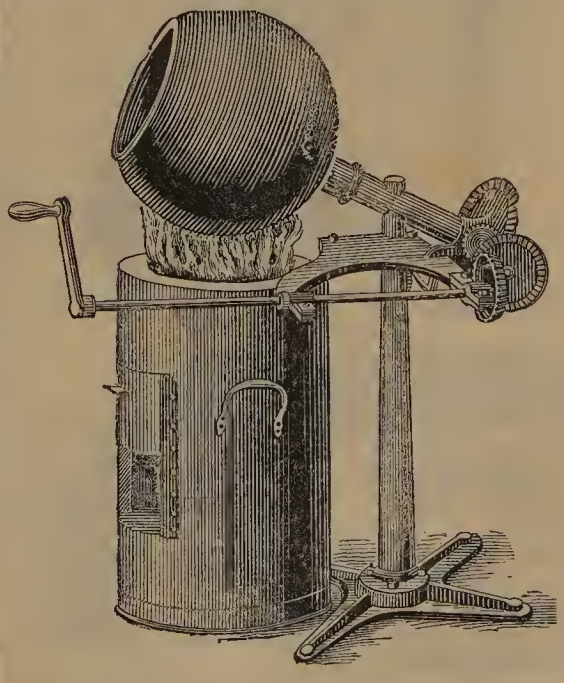
Fig. 1932.



Pillar. Shaper.

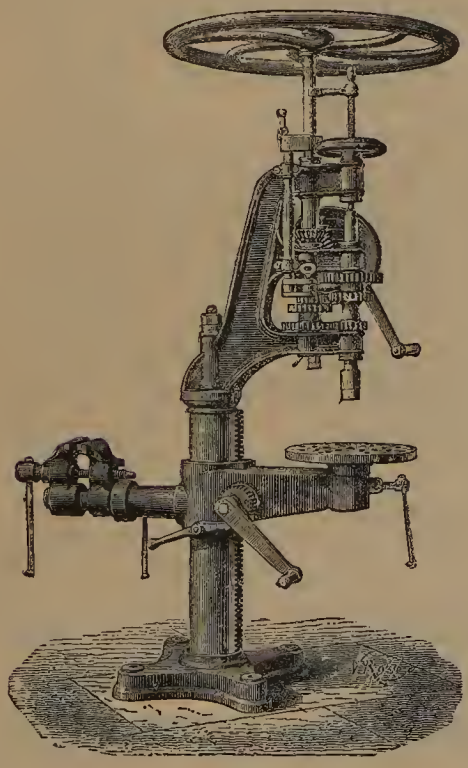
The 10″ machine, for instance, stands on a hollow column, the base of which measures 36″ by 27″. The stroke may be graduated to any point within its extreme limit, the cutter-slide has a quick return, and the cross-feed is automatic and

Fig. 1933.



Pill Coater.

Fig. 1931.



Treble-geared Pillar Drilling Machine.

adjustable. The planer-vise has a slide base and operating screw; length of stroke, 10″, traverse of bed, 16″; distance between table-top and bottom of slide, 11½″.

Pratt & Whitney . . . . . * "*Engineer*," xlii. 24.

Pill Coat'er. A machine like a comfit-making machine, in which pills are coated with sugar.

A regular rotary motion is given to the pan, which tumbles the pills over each other, exposing them to the saccharine matter which adheres to them, while the constant motion prevents mutual adherence. See Fig. 1933.

Pill coating, *Bull* . . . "*Sc. Amer. Sup.*," 2065.
Pill printing, *Vial* . . . * "*Sc. Amer.*," xliii. 194.
Confection pan . . . . * Fig. 1428, p. 611, "*Mech. Dict.*"
Brown . . . . . "*Engineer*," xli. 226.

Pin. (*Surgical.*) Pins are used in securing parts, sutures, and what not. The primary idea is that a pin remains *in situ*, a while at least, while a needle makes a temporary puncture or carries a thread. Some varieties of the *acus* are, however, less transitory.

Harelip pin, with removable point, and plastic pin with conductor, p. 60, Part II., "*Tiemann's "Armam. Chirurg.*"
Hemorrhoidal, Fig. 599, Part III., *Ibid.*

(Toilet):
Pin industry, history of . "*Iron Age*," xxiv., Dec. 4, p. 11.
French series of operations "*Épingle*," *Laboulaye's "Dict.*" ii.
Pin machine . . . . . "*Iron Age*," xvii., May 18, p. 20.
Pin machinery . . . . "*Sc. Amer.*," xli. 261.

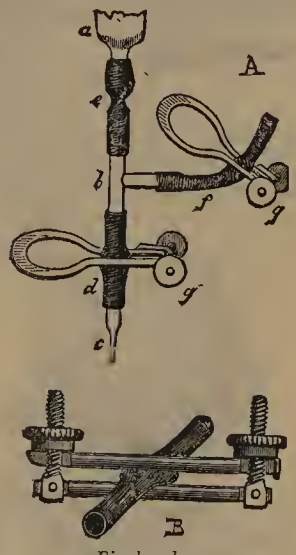
Pin'-ball Sight. (*Rifle.*) Another name for the *bead-sight;* also called pin-head sight. Left-hand illustration, Fig. 249, p. 84, *supra.*

Pin Bush. A reaming or polishing tool for pin holes.

Fig. 1934.

Pin Bush.

Fig. 1935.



Pinchcocks.

A. Mohr's Pinchcock.
B. Bunsen's Pinchcock.

Pinch'cock. A clamp on a flexible pipe to regulate the flow of fluid or liquid, so as to keep up a constant action at a fixed rate.

Pinch'er. (*Glass.*) A nipping tool fitting the inside and outside of a bottle, in order to shape the mouth.

(*Metal.*) Componnd lever * "*Iron Age*," xxiv., Sept. 18, p. 7.
Cutting, *Hall* . * "*Scientific Amer.*," xxxix. 388.

Pin'ion Jack. (*Milling.*) A jack for raising the stone pinion out of gear. This attachment works from below.

Another and simpler device for raising the pinion from above has a shaft worked by a hand wheel with ratchet stop, and having short chains and hooks, which are caught under the arms of the pinion, and raised by the turning of the shaft.

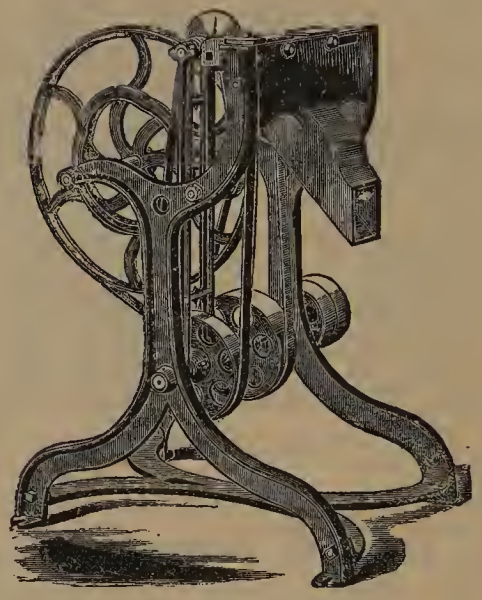
Pink'ie. A fishing vessel with a high, narrow-pointed stern. Used in the cod and coast fisheries.

Pin Ma-chine'. 1. Toilet pin. See p. 1705, "*Mech. Dict.*"

2. A machine for making wooden pins, for securing mortise and tenon joints, for dowels, etc. It is especially used in making the pins used in sash, blind, and door factories.

The square stuff is fed into the machine, rounded by passing through a hollow mandrel, and pointed by a rotary

Fig. 1936.



Wooden Pin Machine.

pointing cutter. The machine will cut off the pins at any desired length, and leave them round or square Cuts and points 80 to 130 pins per minute; length, ½″ to 4″; diameter, ¼″ to 5-16″.

Pin Stick'ing Ma-chine'. A machine for sticking pins in paper.

The pins in bulk pass from a hopper into an inclined, slotted chute, down which they move, supported by their heads. At the bottom of the chute the pins are received singly between the projecting threads of a screw shaft, and are moved horizontally over a warped guiding and supporting surface shaped to gradually change the pins moved over it from a vertical to a horizontal position. Each pin, after it is placed in a horizontal position, is released from the control of the screw or feeding shaft, and is delivered under a spring presser or holder, and then a reciprocating driver strikes the head of, and projects the pin horizontally forward and through parallel, projecting, longitudinal ribs formed on a long strip of paper led from a suitable reel. The paper is ribbed or crimped longitudinally for the reception of the pins by the action of a foot and a wheel, between which the paper passes. The strip, with pins inserted, is then cut into proper lengths and wound on a mandrel to form rolls, which are then pressed between a concave and convex matrix into pyramidal form.

Pin Switch. (*Telegraphy.*) A simple and efficient method of connecting wires and loops with instruments, or changing from one line to another. The connections are made with pins or plugs, which give a rubbing or frictional contact when thrust into the holes on the board. See Lock Switch.

Pi'o-scope. A milk test by Prof. Heeren.

It consists of a disk of black vulcanized caoutchouc, having in its middle a flat circular depression. A few drops of the milk in question, well mixed, are placed in the hollow and covered with the second part of the apparatus — a plate of glass painted with six shades of color radiating out from a

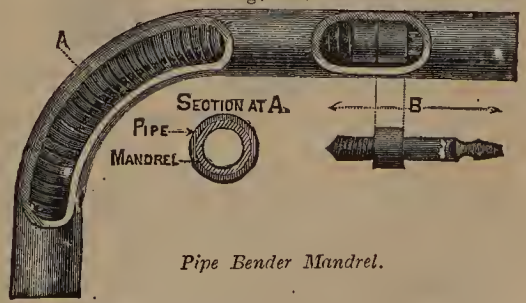
small, uncovered, circular spot in the middle. The colors range from white gray to deep bluish gray. The layer of milk is seen through the uncolored spot in the center, and its color can thus be compared with the radiating colors, and its quality judged according to the color with which it coincides. The whiter the color the more creamy the milk. See LACTOSCOPE and references *passim*.

Pipes, Valves, and Plumb'ing. Apparatus included under the following heads: —

Adapter.
Angle check-valve.
Angle cock.
Angle pressure valve.
Angle valve.
Back-pressure valve.
Ball-and-socket pipe.
Basin cock.
Basin grate.
Basin plug.
Basin stopper.
Basin trap.
Basin waste.
Basin wrench
Bath.
Bath-boiler union.
Bath cock.
Bath tub.
Bath-tub strainer.
Bell.
Bend
Bevel hub.
Bibb.
Bidet.
Bidet pan.
Blank flange.
Blow-off cock.
Blow-off hose cock.
Blow-through cock.
Bottle capsule.
Bottle carrier.
Bottle holder.
Bottle jack.
Bottle stopper.
Bottle washer.
Bottling machine.
Box valve.
Bracket cock.
Branch.
Bulk head union.
Bung.
Bushing.
Can.
Cap.
Carboy.
Centrifugal filter.
Cesspool trap.
Champagne apparatus
Check valve.
Chipping knife.
Clear-way hydrant.
Closet cistern.
Coil. See varieties under HEATING AND LIGHTING APPARATUS.
Combination basin cock.
Commode.
Compression cock.
Cone joint.
Conical valve.
Corking machine.
Cork wiring.
Corner valve.
Corporation stop.
Counter cock.
Cross.
Cross valve.
Curve.
Decanting apparatus.
Diaphragm valve.
Differential screw pipe-joint.
Double-bell pipe.
Double-connecting section.
Double-face valve.
Double fire-cock.
Double-hub bend.
Double valve.
Double-Y branch
Drain cock.
Drain grate.
Drain pipe.
Draw-off cock.
Dresser.
Drop elbow.
Drop tee.
Dudgeon expander.
Earth closet.
Elbow.
Ell.
Equilibrium valve.
Exhaust nozzle.
Expansion joint.
Faucet.
Ferrule.
Filter.
Filtering apparatus.
Flange.
Flange coupling.
Flange pipe.
Flexible valve.
Floating board.
Float valve.
Flush box.
Flushing box.
Flush joint.
Foot valve.
Forty-five ° elbow.
Four-way cock.
Frost valve.
Fullway valve.
Gage cock.
Gas bath.
Gas drip box.
Gas pipe.
Gas soldering apparatus.
Gas trap.
Gas valve.
Gate valve.
Gland cock.
Globe valve.
Gooseneck.
Ground cock.
Gulley trap.
Half hose-coupling.
Half-S hopper trap.
Half-S trap.
Half trap.
Hand hole trap.
Hawser pipe.
H-branch.
Hopper.
Hopper closet.
Hopper cock.
Horizontal check-valve.
Hose.
Hose cart.
Hose clamp.
Hose coupling.
Hose nipple.
Hose pipe.
Hose screw.
Hose sprinkler.
Hose union.
Hose union cap.
Hose wrench.
Hub.
Hydrant.
Hydrant cock.
Hydrant nozzle.
Hydrant suction.
Hydrant valve.
Hydrostatic joint.
Injection check valve.
Inserted joint.
L.
Lateral branch.
Latrine.
Leaden pipe.
Lever and cam valve.
Lever faucet.
Lever-handle cock.
Liquor cock.
Lock faucet.
Main.
Molasses gate.
Mushroom strainer.
Nipple.
Nozzle.
Offset.
Offset pipe.
Oil pipe.
Oil pipe line.
Open return bend.
Pantry cock.
Pavement pipe.
Pet cock.
Pipe.
Pipe connection.
Pipe coupling.
Pipe covering.
Pipe fittings.
Pipe joint.
Pipe-laying apparatus.
Pipe line.
Pipe reducer
Pipe stop.
Pipe union.
Pitcher nose.
Plug.
Plug basin.
Plug cock.
Plug valve.
P-trap.
Quarter bend.
Quarter-turn gooseneck.
Racking faucet.
Rain and well water stop.
Reducer.
Reducing coupling.
Reducing tee.
Reflux valve.
Regulating valve.
Retaining valve.
Return bend.
Return valve.
Ring valve.
Rose.
Round way cock.
Running trap.
Screw-down stop cock.
Screw valve.
Seal.
Self-closing faucet.
Service cock.
Sewer-gas check.
Sewer-gas trap.
Sewer-trap.
S-hopper trap.
Shower bath.
Sink.
Sink pipe.
Sink plug.
Siphon.
Siphon bottle.
Siphon-cleaning box.
Siphon filler.
Siphon pipe.
Siphon trap.
Slab.
Slant.
Sleeve.
Slide valve.
Sluice.
Sluice valve.
Socket.
Socket pipe.
Soda-water apparatus.
Soda-water fountain.
Soda-water fountain cock.
Soda-water machinery.
Soil branch.
Soil pipe.
Soldering nipple.
Stand pipe.
Stand post.
Starting valve.
Steam trap.
Steam valve.
Stench trap.
Stop valve.
Straightway valve.
Strainer.
Strainer foot valve.
S-trap.
Street washer.
Street washer screw.
Stuffing cock.
Suction basket.
Suction butt.
Swinging coupling.
Swinging valve.
Swing joint.
T.
Tail pipe.
Tank check valve.
Tank regulator.
Tank screw.
Tank valve.
Tap.
Taper screw joint.
Tap-hole protector.
Tasting cock.
T-branch.
Tee.
Telegraph cock.
Telegraph faucet.
T-handle.
Thimble.
Three-quarter-S trap.
Three-way cock.
Throttle damper.
Tide flap.
Tip-up basin.
Trap.
Trap mold.
Tube.
Tube valve.
Twin safety valve.
Union.
Vacuum valve.
Valve gearing.
Vertical check-valve.
Wash basin.
Wash-basin valve.
Wash stand.
Wash-tub waste.
Waste.
Waste preventer.
Waste stop-cock.
Waste way.
Water-back coupling.
Water closet.
Water gate.
Water main.
Water pipe.
Water shoes.
Water valve.
Wedge valve.
Weighted gage-cock.
Wiped joint.
Wiring staud.
Y.
Y-branch.
Y-cross.
Yoke.

Pipe Bend'er, 1. A mandrel consisting of a

Fig. 1937.



Pipe Bender Mandrel.

strong closely-wound steel helix of uniform exterior diameter and somewhat longer than the pipe to be

bent. This is thrust into the pipe and keeps it from becoming distorted. See FLEXIBLE MANDREL, Fig. 1058, p. 347, *supra*.

2. Miller's machine for bending stove-pipe elbows consists of sets of clamps in pairs which seize the pipe, and, turning on horizontal axes, force it to bend at each operation through a small angle. The pipe is then released and a new hold taken at a point a little farther along, and the operation repeated until the pipe has been given the required bend.

Pipe Coup'ling. A joint or piece to connect two pipes or a pipe with another object.

See: Bell. Bend. Branch. Cross. Elbow. Expansion joint. Hub. Offset. Reducer. Sleeve. Tee. Y.

Pipe Cut'ter. 1. A machine for cutting pipe into lengths or truing the ends. Associated with a threader in Fig. 1744, p. 1712, "*Mech. Dict.*"

2. A tool for cutting off pipes. Four forms are shown in Figs. 3735–3738, p. 1711, "*Mech. Dict.*"

Fig. 1938 is a form in which the body of the tool is threaded internally for the reception of the threaded end of the stem of the handle, and has at the rear a chamber for the reception and guidance of the stem of the movable jaw. This stem has a screw thread cut upon it so that it can be moved

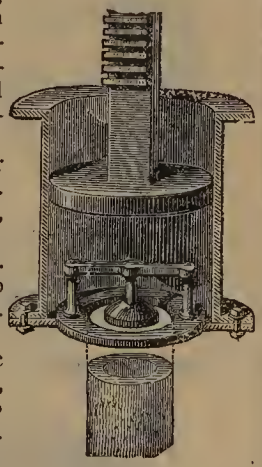
Fig. 1938.

"*Acme*" *Pipe Cutter.*

in or out by means of a knurled nut. The pipe is cut by a chisel on the end of the handle stem which is fed into the pipe by means of the thread on the stem, while the tool is revolved around the pipe.

Pipe Die. 1. (*Ceramics.*) Pipes of stone-ware are made in a press, in the usual manner of pressing the plastic clay out of an annular hole made by suspending a cone in the circular exit. They are finished with a lead glaze and second firing.

Fig. 1939.



Clay-pipe Die.

2. The threaded nut for chasing a screw on a pipe. See Figs. 812–815, p. 256, *supra*.

Pipe Fit'ter's Vise. See PIPE VISE, *infra*, also Fig. 3752, p. 1713, "*Mech. Dict.*"

Pipe Fit'tings. See list under PIPE TOOLS, etc., *infra*. Also GAS PIPES AND CONNECTIONS, Fig. 1174, p. 390, *supra*.

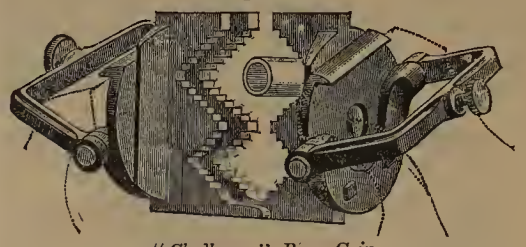
Pipe Grip. Toothed or stepped jaws, to be placed in a vise, to hold round objects, such as pipes and rods.

In Fig. 1940 the device adjusts itself to any size, one jaw slipping between the two apposed ones. A capacity for rotation in a vertical plane enables the jaw to grasp the pipe at any vertical angle. The dotted lines indicate the jaws of the vise. See also PIPE VISE, p. 1713, "*Mech. Dict.*"

Pipe Kiln. The form of kiln used in France for baking clay pipes is shown in Fig. 1941.

B is the furnace, *A* the chamber with pipe trays *r* of refractory material on a central stem. *N* is the chimney; *D* the walls; *E* the aperture for charging and discharging.

Fig. 1940.



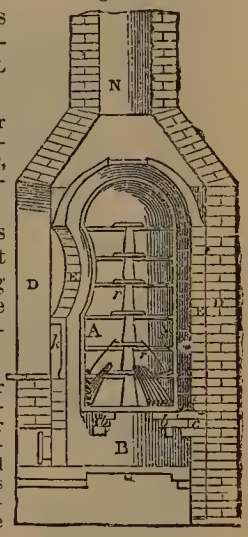
"*Challenge*" *Pipe Grip.*

Pipe Line. A means of transporting liquids by pipes laid above the ground or beneath the surface. See OIL PIPE LINE, *supra*.

Description of pipe lines for transport of beet-root juice to factories, Dr. McMurtrie's report, 1880, in "*Dept. of Agric., Special Report*," No. 28, pp. 131 *et seq.*

Pipe Mold. Primard's mold for iron pipe to be cast vertically is a metallic casing rolled in a spiral and capable of being expanded or contracted at will.

Fig. 1941.



French Pipe Kiln.

"A plunger attached to the lower end of a spindle, and having a diameter equal to the outer diameter of the pipe, passes through the interior of the casing, which is placed in the center of the mold. This spiral casing is placed in its contracted state into the center of the mold, and sand is run between them. The plunger, in passing through the spiral, enlarges it and compresses the sand uniformly. When it is withdrawn the spiral contracts and may be easily withdrawn. The casting of the neck and flange on one end of the pipe is provided by a simple contrivance." — "*Moniteur Industriel.*"

Pipe O'ven. A hot blast oven in which the air passes through pipes exposed to the heat of the furnace. In contra-distinction to a fire-brick oven. See HOT-BLAST STOVE, *supra*.

Pipe Re-du'cer. A pipe coupling which is larger at one end than the other, to unite pipes of different diameters. *c*, Fig. 271, p. 92, *supra*.

Pipe Screw'ing. See PIPE THREADER, Fig. 3744, p. 1712, "*Mech. Dict.*"

Pipe Stand. A frame to support radiator pipes. See COIL STAND; COIL PLATE, *supra*.

Pipe Stay. A device to hold a pipe in place; or to hang a pipe.

Pipe Stop. A spigot in a pipe.

Pipe Test'ing Ma-chine'. See PIPE PROVER, Fig. 3741, p. 1711, "*Mech. Dict.*"

Pipes, Tools, and Ma-chin'er-y. See under the following: —

Bend and union, universal, *Royle*, Br.	* "*Engineer*," xlix. 53.
Boring & turning lathe. *Hind*, Br.	* "*Engineer*," xli. 60, 69; xliv. 42.
Coupling, adjustable, Fr.	* "*Engineer*," l. 72.
Smith, Br.	* "*Engineer*," xlvii. 388.
	* "*Scientific American*," xxxv. 118.
Chapell	* "*Scientific Amer.*," xxxviii. 55.
Covering, *Pierce* (air chamber)	* "*Iron Age*," xxiii., March 13, p. 9.
"Acme"	* "*Iron Age*," xviii., Sept. 7, p. 9.
Pipe cutter and threader	* "*Manufact. & Builder*," xii. 78.
Chase	* "*Scientific American*," xlii. 74.
Eaton	* "*Scientific American*," xxxv. 163.
Roberts	* "*Iron Age*," xx., Aug. 16, p. 3.
Sanford	* "*Iron Age*," xviii., Aug. 24, p. 16.
Saunders	* "*Scientific American*," xl. 374.
	* "*Iron Age*," xxiv., Nov. 6, p. 7.

Fittings . . . . . * "*Scientific American Sup.*," 1273.
Gas and water . . . . * "*Sc. Am. Sup.*," 985, 1016, 1048, 1060, 1072, 1092.
Hydrostatic joint . . . * "*Iron Age*," xxii., vol. xxiv., p 9.
Joints and pipes . . . * "*Sc. Am. Sup.*," Nos. 62, 64, 66, 67, 68, 69.
Joint, differential screw.
Bourry, Switz. . . . * "*Engineering*," xxiii. 388.
Painter, Br. . . . . * "*Engineer*," xlix. 181.
* "*Engineering*," xxix. 147.
* "*Laboulaye*," "*Eclairage au Gas*," ii., Figs. 69–72.
Thomas . . . . . * "*Scientific American*," xxxix. 88.
Elastic, *Roche* . . . "*Scientific American Sup.*," 396.
Laying apparatus . . . * "*Scientific American Sup.*," 1109, * 1137, * 1217.
Pipe maker's oven . . * "*Scientific American*," xl. 82.
Manufact. wrought iron * "*Iron Age*," xxi., May 16, p. 3.
* "*Scientific American Sup.*," 2164.
Plumbing . . . . . "*Scientific American Sup.*," 1920.
Press . . . . . *Laboulaye*, iv., "*Poteries*," Fig. 3693.
Screwing machine.
Heap, Br. . . . . * "*Engineer*," xliv. 454.
Tongs, "Acme" . . . * "*Sc. Amer.*," xlii. 246; xliii. 122.
Barnes . . . . . * "*Iron Age*," xxii., Nov. 21, p. 9.
Macdonald . . . . * "*Scientific American*," xxxiv. 274.
Thornton . . . . . * "*Iron Age*," xx., Dec. 20, p. 5.
* "*Scientific Amer.*," xxxviii. 281.
Tongs, wrench, etc., combined, *States* . . . * "*Scientific American*," xxxvi. 310.
Vise . . . . . * "*Scientific American*," xxxvi. 19.
Wooden, *Wyckoff* . . * "*Min. & Sc. Press*," xxxvi. 49.
Wrench, "Cliuiax."
Hull & Belden . . . * "*Manufact. & Builder*," viii. 248.
* "*Iron Age*," xviii., July 27, p. 1.
Coleman . . . . . * "*Sc. American*," xxxviii. 264.
Tuland . . . . . * "*Scientific American*," xxxix. 310.

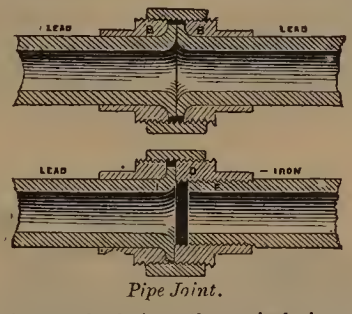
Pipe Turn'buck-le. A pipe or rod coupling, consisting of a pipe with internal threaded ends, having respectively right and left-hand threads. Into these the ends of other threaded pipes or rods are inserted, and by rotating the turnbuckle are drawn towards each other.

Its function is the same as that of the ordinary turnbuckle, but the latter is made of rods and a link, Fig. 6794, p. 2659, "*Mech. Dict.*"

Pipe Un'ion. A pipe coupling. See 18 varieties, Fig. 3734, p. 1710, "*Mech. Dict.*"

That shown in Fig. 1942 is for connecting lead, or lead and iron pipes without solder.

Fig. 1942.



Pipe Joint.

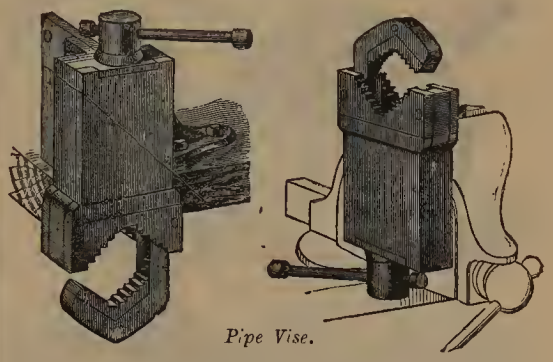
In connecting two lead pipes, the conical rings are placed loosely on the ends; the ends of the pipes are then forced out by a taper plug, the pipes being allowed to project above the rim; the ends are flattened over the edges of the conical rings with a small hammer until they form a flange, as shown on section; the outside hoop is then screwed on, and the whole tightened firmly together by screwing with two spanners in opposite directions.

In connecting a lead and iron pipe, the lead pipe undergoes the same operation as above described, the plain conical ring being placed on the end of the lead pipe, and the screwed ring on the iron pipe, the face of the ring being firmly screwed up to the face of the lead pipe.

Pipe Vise. A special vise for pipes. Attachments to vises, to enable them to grasp pipes and rods, are shown under PIPE GRIP, *supra*. PIPE VISE, VISE, "*Mech. Dict.*"

The *Pancoast & Maule* vise, shown in Fig. 1943, can be used either as a permanent fixture to a work-bench, attached to an angle plate, or can be held between the jaws of any machinist's or blacksmith's vise. The movable jaw being open on the side permits work to be gripped at any desired point without slipping it in from the end; the box is made of malleable iron, the screw of wrought iron, and the remainder of solid steel. The steel gripping jaws can be duplicated and replaced when worn out.

Fig. 1943.



Pipe Vise.

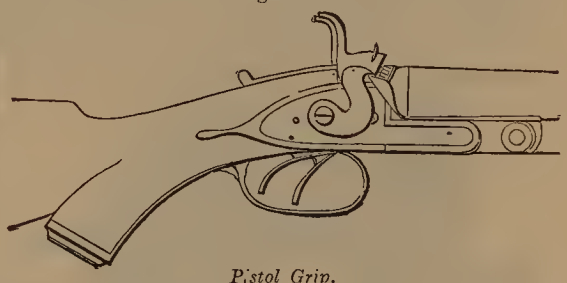
See also Fig. 3752, p. 1713, "*Mech. Dict.*;" Fig. 6986, p. 2713, *Ibid.*

Pis'ci-cul'ture. See FISH CULTURE, OYSTER TOOLS, etc.

Pis'tol. See REVOLVER.

Pis'tol Grip. A protuberance shaped like the butt of a pistol beneath the *small* of a gun or rifle stock, to be grasped by the right hand, to give steadiness to the grip in firing.

Fig. 1944.



Pistol Grip.

Pis'tol Ri'fling Ma-chine'. A standard machine cuts 5 grooves of an invariable pitch, in barrels 3.5″ to 5″ long, with or without feed for depth of grooves. See RIFLE, p. 1939, "*Mech. Dict.*"

The twist may vary from 1 turn in 72″ to 1 turn in 12″. — *Pratt & Whitney.*

Pis'ton. See numerous illustrations, Figs. 3757–3759, pp. 1714–1716, "*Mech. Dict.*"

Church, Br. . . . . * "*Engineer*," xlii. 281.
Rowan, Br. . . . . * "*Engineer*," xlix. 235.
Expanding, *Wood* . . "*Iron Age*," xxi., March 14, p. 1.
* "*Scientific American*," xxxv. 182.
Packing, *Sprague* . . * "*Iron Age*," xxi., March 7, p. 1.
Packing, *Hewitt* . . . * "*Railroad Gazette*," xxiii. 678.
* "*Scientific Am. Sup.*," 690, * 293.
Packing, metallic, *Leg & Parker*, Br. . . . . * "*Engineering*," xxii. 191.
Pump, Ship's, *Blundell*, Br. * "*Engineer*," xliii. 94.
Ring, *Dubied*, Fr. . . . * "*Engineering*," xxi. 107.
Piston-rod lathe.
Schönheyder, Br. . . * "*Engineering*," xxi. 142.
Piston-rod lathe . . . * "*Scientific American Sup.*," 349.
Rod packing, *Fuller* . . * "*Eng. & Min. Jour.*," xxv. 421.
Hewitt . . . . . * "*Scientific American*," xli. 98.
Metallic, *Jagge*, Br. . * "*Engineer*," xlv. 465.

Pis'ton Pack'ing. See 22 figures illustrating different forms of piston packing, pp. 1715, 1716, "*Mech. Dict.*"

See also list of patents on pp. 1717, 1718, *Ibid.*

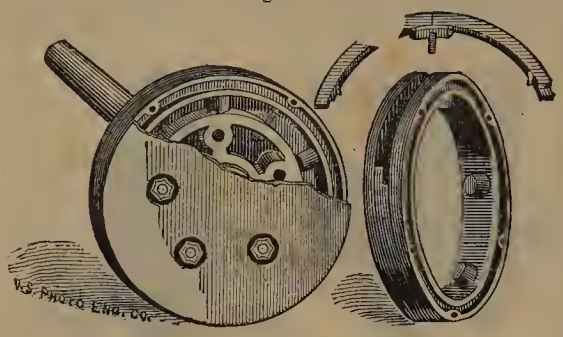
The Babbitt & Harries piston-packing is shown in Fig. 1945, which has three views.

One represents the packing in its place in the piston.

Another shows the chunk ring with two sections of the packing out.

A third shows two sections of the packing ring with its accompanying spring plate and spring.

Fig. 1945.



Piston Packing.

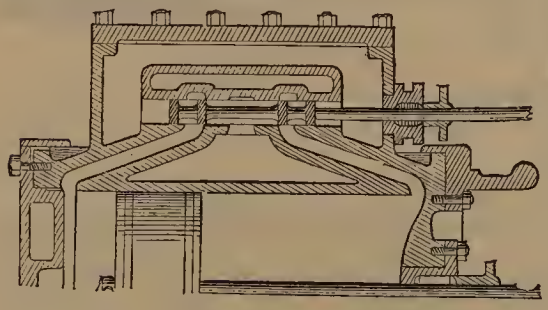
The operation of the packing is as follows: When steam is admitted into either end of the cylinder, the packing ring is carried by the steam over to the side of the grove in the chunk ring, making a joint there, and allowing the steam to pass down by and under the packing ring, thus placing it in equilibrium, when a very light spring is able to do the holding of the packing in contact with the bore of cylinder.

The piston-rod packing of Herr Gehrckens, of Hamburg (Philadelphia, 1876), is a wick-twisted hose stuffed with animal and mineral grease, and coiled around the piston-rod in the stuffing-box. See PACKING, Fig. 1860, *supra*.

Pis'ton-pack-ing Ex-pand'er. A steel spring in a piston head, to expand the packing against the inside of the cylinder.

Pis'ton Valve. A circular valve moving in a cylindrical chamber. That used on the Norwalk Iron Works Steam Engine, consists of two peculiarly constructed pistons connected by a rod, and is

Fig. 1946.



Piston Valve of N. Y. Safety Steam Power Co. Engine.
(*Section of Valve and Steam Cylinder.*)

worked by an ordinary eccentric. By a simple arrangement these pistons always have the same pressure inside as out, which prevents any leakage or blowing through.

Pitch, Mu'si-cal. In addition to what was said on p. 1719, "*Mech. Dict.*," reference may be had to a late paper read before the American Association, "*On the Present Condition of Musical Pitch in Boston and Vicinity*," by Charles R. Cross and William T. Miller. It is summarized on p. 4041 of the "*Scientific American Supplement*."

It recounts an extensive series of experiments carried on in 1880 at the "Massachusetts Institute of Technology," to determine the amount of variation of standard pitches in use by different makers of musical instruments in the neighborhood of Boston.

	No. of Vibrations. C 3.
Variations extended from Koenig's physical pitch . .	256.1
Chickering	268.5
Covent Garden	270.3
Weber	270.3
Thomas	271.1
Music Hall	271.2
Steinway	272.2

Pitch'er Nose. Said of a faucet with a bent down lip.

Pitch Faced. (*Masonry.*) The arris is cut true, but beyond the arris edge the face is relatively rough and projecting, the *face* being merely dressed with a *pitching* chisel.

Pit Guide. A vertical bar forming a guide for the cage in mining shafts.

Pit Head Gear. The winding and emptying apparatus and framing for the transportation cars at the mouth of a mining or coal shaft.

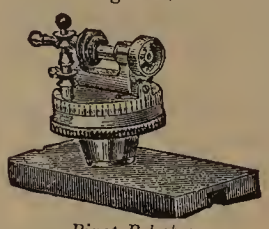
Pit'man Press. One working by pitman connection with a shaft, instead of eccentric or other equivalent. Used in drawing, cutting, stamping, and shearing presses.

Pit'ter. A device to take the pits from peaches, plums, and other stone fruit. See FRUIT PITTER, Fig. 1107, p. 359, *supra*.

Piv'ot Pol'ish-er. An attachment to the watchmaker's lathe.

It is used for grinding and polishing conical pivots, snailing and drilling. The circular base being graduated into degrees, it can be set to grind at any angle. It has a finely graduated elevating screw to adjust the spindle above, or below, the center of the headstock.

Fig. 1947.



Pivot Polisher.

The spindle has a taper hole for drill chucks This makes it very useful for drilling, either in the center or eccentric, and by using the graduations on the pulley of the headstock, an accurately spaced circle of holes may be drilled.

Piv'ot Span. (*Bridge.*) The draw span of a bridge. See DRAW-BRIDGE, *supra*, and references *passim*; PIVOT BRIDGE, Fig. 3775, p. 1721, "*Mech. Dict.*"

Pla-cen'ta In'stru-ments. (*Surgical.*) For the removal of the after-birth. Forceps, hook, etc.

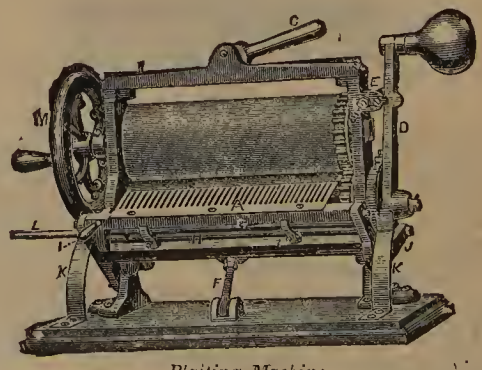
Pla'cer. (*Mining.*) A gravelly place where gold is found; includes all forms of mineral deposits excepting veins in place. Section 2,329, "*Revised Statutes of the United States.*"

Plain Sight. (*Fire-arms.*) A hind sight consisting of a simple notch in a raised plate or protuberance.

Plait'ing Ma-chine'. A machine for plaiting goods in piece or strips.

The roller is heated by gas or hot irons, and in the domestic size, it plaits strips up to 6″ wide, the plaits ⅛″ to ⅝″ wide. The goods are placed under the knife *A*, and between

Fig. 1948.



Plaiting Machine.

the rollers; then push down the handle, *C*, and the machine is ready. Move the lever *D* back and forth; this forms the plait, and presses it between the rollers. To change the width of plait, turn the nuts on the curved screw *E* back to the next notch on the screw, then lower the plaiting knife by adjusting the nut on screw *F*. There are 7 notches on each of these screws, answering to as many widths of plait.

See also "Crown" machine, * "*Iron Age*," xx., Nov. 29, p. 1.

Plane. A smoothing tool, having its cutter protruding from a throat in a stock.

See ADJUSTABLE PLANE, Fig. 7, p. 5, *supra;* CIRCULAR PLANE, Fig. 620, p. 197, *Ibid.;* BELL-NOSE RABBET PLANE, Fig. 460, p. 110, *Ibid.;* HAND MATCHER, Fig. 1305, p. 433, *Ibid.;* HAND PLANER, Fig. 1307, p. 434, *Ibid.;* PLOW, *infra;* SMOOTH PLANE, *infra.*

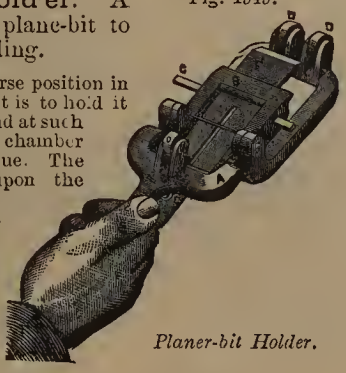
Description, illustrations, and list of varieties, pp. 1724, 1725, "*Mech. Dict.*"

See Figs. 3782-3784, and list of planes, pp. 1724, 1725, "*Mech. Dict.*"

See: Bench,	*Boyce & Bruce*	* "*Scientific Amer.*," xxxviii. 191.
Carpenter's,	*Bailey* . .	* "*Scientific American*," xl. 1.
	Gallaher	* "*Scientific American*, xl. 5.
Metallic		* "*Manuf. & Builder*," x. 88.
Rabbet plane,	*Bonney* .	* "*Iron Age*," xxii., Nov. 14, p. 5.
Rabbeting, grooving and turning mach.,	*Wood*	* "*Manufact. & Builder*," x. 64.

Plane'-bit Hold'er. A device to hold a plane-bit to the stone for grinding.

Fig. 1949.



Planer-bit Holder.

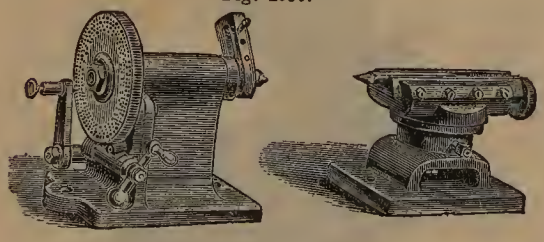
It is shown in reverse position in Fig. 1949. The object is to hold it firmly and squarely and at such an angle that the chamber shall be flat and true. The rollers *D D*, run upon the stone and it is impossible to grind the bit awry.

Pla'ner Cen'ter. A head and tail stock bolted to the table of a planer in order to hold objects centered while under treatment.

In the instance shown, Fig. 1950, the device is practically a pair of lathe stocks; the head stock has a dial with worm, gear, and index wheel. The foot stock has horizontal traverse by means of feeding screw.

See also Fig. 3788, p. 1726, "*Mech. Dict.*"

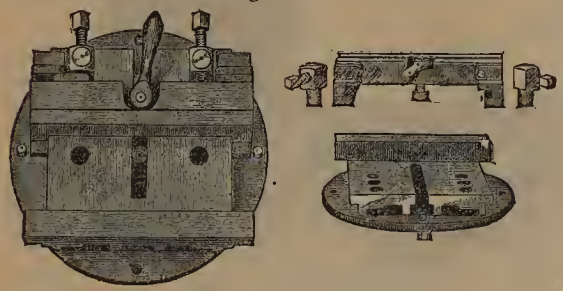
Fig. 1950.



Planer Center.

Pla'ner Chuck. A device bolted or keyed to the planer table, and serving to dog an article under the action of the plane.

Fig. 1951.



Pratt & Whitney's Planer Chuck.

The chuck shown is adapted to hold regular or irregular pieces, and can be readily adjusted from the least to greatest capacity. The round swivel-base chucks are for azimuth adjustment.

Pla'ner Knife Grind'er. An emery-wheel or stone, traversing on its mandrel in front of a knife dogged to the table or conversely.

See KNIFE GRINDER, Fig. 1515, p. 520, *supra*, and Fig. 2765, p. 1233, "*Mech. Dict.*"

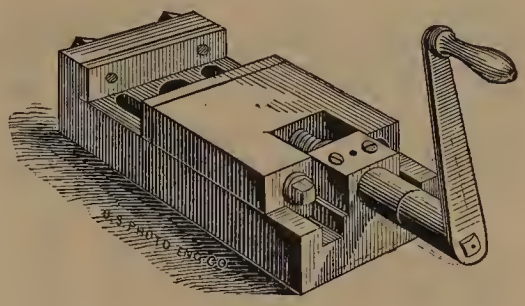
Pla'ner Vise. A device to hold work on the bed of a planing machine while under treatment.

Fig. 1952 shows a form in which the moving jaw is actuated by crank-handle and screw.

Fig. 1953 is Babbitt's planer vise.

In this chuck, instead of gripping the work with the vise jaws direct, two pivoted plates are interposed which incline

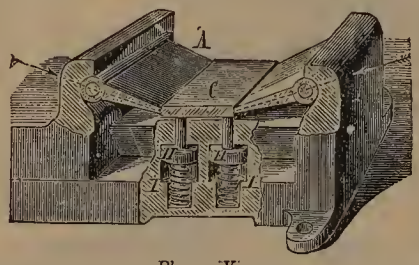
Fig. 1952.



Planer Vise.

from the pivots towards the work. *A* and *B* represent these plates, and *C* represents the work; the strain of the plates upon the work is in the direction denoted by the respective arrows, so that the work is forced downwards upon the tops of the pins. The plates are made to bear, at the back of the hinge, upon the hollow curve in the chuck jaws, as shown,

Fig. 1953.



Planer Vise.

which relieves the pivot of the strain due to screwing the chuck tightly.

The pins are made adjustable for height to suit the work, being screwed into the disks *H* which are attached to spiral springs, which depress until the disks *H* meet the shoulder at *I*, resting solidly upon them.

Harris; Thomas . . . "*Sc. American*," xxxviii. 245.

Pla'ni-graph. An instrument invented by Marmet, of Versailles, France, for reducing or enlarging drawings.

It consists of a rule carrying two scales which have different graduations, and are placed end to end in opposite directions. At the common origin of the scales is a needle about which the rule can freely turn. Reading on one side the radii vector of the different points of a given figure, and marking on the other side the points designated by the same numbers, you obtain a figure reduced or enlarged in the proportion resulting from comparison of the scales. The scales are fixed to the rule by screws. There are five for each side, among which choice is made according to the reduction required.

"*Scientific American*" . . . . . xxxvi. 328.

Pla-nim'e-ter. An instrument for measuring the area of plane figures.

Amsler's planimeter is shown in Fig. 3794, p. 1728, "*Mech. Dict.*"

Ljungström's circular planimeter consists, in its most simple form, of a circular plate of glass, through the center of which passes a vertical steel wheel that is to be placed at right angles to a radius which is etched in the pane and marked with a point. When in use, the plate of glass is brought along a rectilineal support (a ruler) so that said point accurately follows the border line of the figure once round. The reading is taken from the wheel, which is turned by friction against the paper. The instrument measures figures of a width equal to that of the whole ruler. If very large figures

are to be measured (*e. g.* an ordinary map at once) the instrument is changed by a so-called *couple* into a kind of polar planimeter. The *couple* consists of a metal ring, which goes round the pane of glass, together with two legs, one of which is attached to the ring, and the other to the plate. The former moves about a fixed point, while a point marked on the other leg is moved along the border-line of the figure. The reading off is in this case also done from the steel wheel.

See also *"*Eng. & Min. Jour.,*"* xxvi. 24; *"Planimetre,"* *Laboulaye's "Dict.,"* vol. iii.

Plane tables, *Cutts's*, *"Report on Vienna Exposition,"* ii., Sec. II, p. 8.

Austrian.	Swiss.
Japanese.	*Stupendorf*, Rus.

Pla'ning Ma-chine'. The subject of planing machine for *wood* has been considered on pp. 1728–1730, *"Mech. Dict.,"* and for metal on pp. 1730, 1731, *Ibid.*

In addition, the divisions of the subject have been considered under the titles and in places mentioned in *"Mech Dict."*

Wood.	Fig.	Page.
Bark planing machine	566	233
Cylinder planer	3797	1729
Dimension planer	3798	1729
Felly planer	1940	832
Molding machine	3197	1467
Molding and recessing machine	3201	1468
Panel planer	3502	1602
Planing and matching machine	3797	1729
Planing and molding machine	3198	1467
Shaper	4916	2133
Shingle planing machine	4995	2152
Spoke planer machine	5453	2233
Surface planer	6081	2457
Surfacing machine	6082	2458
Transverse planer	3795	1728
Traversing planer	6627	2620
Trying-up machine	6714	2640
Variety planing machine	3200	1468
Veneer planing machine	6944	2701
Metal.		
Milling machine	3151	1441
Planing machine	3800	1731
Shaping machine	4912–4	2132-8
Transverse planer	6616	2616
Traveling bed planer	3799	1730

See also Pillar Shaper; Milling Machine, etc., *supra.*

Richards's classification of planing machines divides them into three classes: —

1. The *carriage planing machine*, in which the material is carried and guided on a carriage having its movement governed and regulated by extraneous guides and independent of its own surface or shape. — The *Daniel* planer, Fig. 3796, p. 1728, *"Mech. Dict."*

The carriage planing machine requires a length double that of the material to be worked; that is to say, the track must be twice the length of the carriage, the movement of which is reciprocating.

2. The *parallel planing machine*, such, for instance, as have feed-rollers over which the material is fed and gaged from, forming a fixed gaging surface opposite to the cutters.

3. The *surface planing machine*, having its action gaged from the surface of the material, cutting a constant amount without reference to dimensions or to producing parallel lines.

Wood.

See also: History of . *"Sc. Amer.,"* xxxvi. 115, 135, 147, 200.

Arbey, trying up mach., Fr. . . . . * *"Engineer,"* xlvii. 237.
Portable . . . . . * *"Iron Age,"* xx., Nov. 29, p. 1.
Fay . . . . . * *"Engineer,"* xlv. 439.
Surface . . . . . * *"Scientific Amer.,"* xxxvii. 246.
Hand and power . . *"Scientific American,"* xxxv. 406.
Frank . . . . . * *"Sc. American,"* xxxviii. 297.
Furness, molding mach. Br. . . . . * *"Engineer,"* xlvii. 301.
Fay, matcher . . . . * *"Scientific American,"* xxv. 147.
Goodell & Co. . . . . * *"Manufact. & Builder,"* viii. 9.
Woods & Co. . . . . * *"Man. & Builder,"* viii. 102, 175.
Gray & Woods, dimension * *"Manufact. & Builder,"* viii. 126.
Hermance . . . . . * *"Manufact. & Builder,"* xi. 161.
Houston, Smith & Co., endless belt . . . . * *"Manufact. & Builder,"* viii. 241.
Michels . . . . . * *"Am. Man.,"* Feb. 14, 1879, p. 12.
Newman, "Pony" . . * *"Scientific American,"* xxxv. 38.
Norris, Polishing Mach. * *"Scientific Amer.,"* xxxvi. 386.
Robinson, shaping and mortising mach., Br. . * *"Engineer,"* xlii. 98; xlv. 417.
Chuck . . . . . * *"Van Nost. Mag.,"* xxiii. 473.
Recessing, Br. . . . * *"Engineer,"* xlv. 216.
Ross . . . . . * *"Am. Man.,"* Sept. 26, 1879, p. 13.
Rowley & Hermance. Matcher, "Sweep-stakes," . . . . . * *"Scientific American,"* xl. 147.
Tanite Co., knife grinder * *"Scientific American,"* xxxvi. 22.
Whitney . . . . . * *Thurston's "Vienna Report,"* iii. 252.
Richards, transom . . * *"Engineering,"* xxii. 551.

Metal.

See: *Asquith*, Br. . . . * *"Engineering,"* xxvi. 68.
Buckton, for bed plates, Br. . . . . * *"Engineer,"* xlviii. 148.
Ferris & Miles, small . * *"Iron Age,"* xxi., Mar. 14, p. 1.
Kershaw, double tool box, Br. . . . . * *"Engineer,"* l. 420.
Perrin, Pauchard et cie., Fr. . . . . * *"Engineer,"* xlvii. 293.
Pratt & Whitney . . . * *Thurston's "Vienna Rpt.,"* ii. 231. * *"Engineer,"* xlii. 42.
Sellers . . . . . * *Thurston's "Vienna Rpt.,"* ii. 205.
Sharpe, Stewart & Co., Br. * *"Engineering,"* xxvi. 103.

Plan'ish-er. For photograph planisher, see Photograph Burnisher.

(*Photography.*) See Photograph Burnisher.

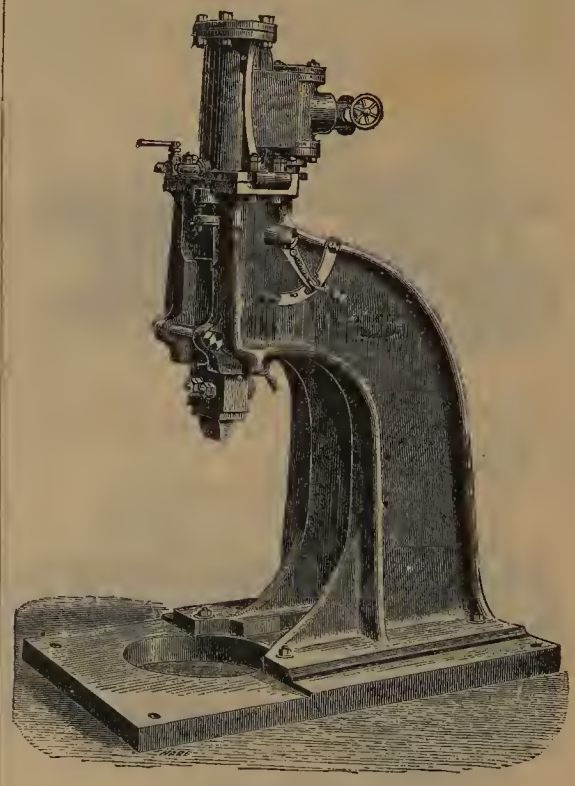
(*Paper.*) See Calender; Plater; Paper Burnisher; Paper-glazing Roller.

(*Metal.*) See Planishing Hammer.

Plan'ish-ing Ham'mer. A hammer for flattening, curving, or shaping sheet metal by properly disposing and graduating the blows upon its surface.

Saw blades are planished to straighten them. Buckling is removed by planishing, *i. e.*, giving a *plane* surface.

Fig. 1954.



Planishing Hammer.

Again: by the planishing hammer sheet metal is shaped to form kettles and what not. When the curve is regular and cylindrical the work is done by rollers. See Plate Bending Machine, *infra.*

When the object admits of being made by a stamping process, as a dish or pan, the work is done at a blow or by a series of blows.

The old mode of forming the 60 gallon copper, sugar, or soap-kettle was planishing, the parts being subsequently

united by brazing. The planishing hammer is yet a valuable tool and very effective, especially when worked by steam.

Plan'i-sphere. An instrument to assist in the study of the stellar heavens.

It consists of a card about 4″ square, carrying a circumpolar star-map, surrounded by a circle of the months subdivided for the days; and a smaller circular card, carrying the hours of the day, and an open space representing the horizon. These two cards are attached at the center, so as to turn one on the other.

Plan-ta'tion Lo'co-mo'tive. A four-wheeled locomotive, for use in plantation work. The tank is at the rear, beneath the floor of the cab, over which is a sheet-iron canopy. One pair of driving-

Fig. 1955.

Plantation Locomotive.

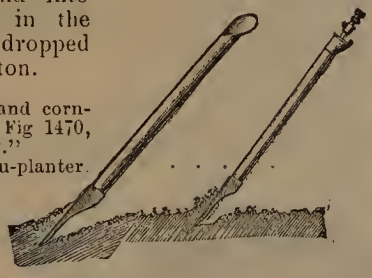
wheels is equalized across. The hauling capacity on a level is from 150 to 475 tons, with engines of from 5 × 10″ to 9 × 14″, and diameter of driving wheels, 22″ to 28″.

Plan'té Bat'te-ry. See SECONDARY BATTERY.

Plant'er. A tool or machine for planting grain or roots in hills.

Two French hand-planters are shown in Fig. 1956. In one form the seed is dropped by hand into the open end; in the other the seed is dropped by moving a piston.

Fig. 1956.



Hand Planters. (French.)

The American hand corn-planter is shown in Fig 1470, p. 627, "*Mech. Dict.*"

The horse corn-planter. Figs. 1468, 1469, p. 627, *Ibid.* See also CORN PLANTER, Fig. 697, p. 223, *supra.*

POTATO PLANTER. See Fig. 3919, p. 1776, "*Mech. Dict.*" Also see *infra.*

Plant Sprink'ler. A syringe for watering plants.

In the form shown in Fig. 1957 it is a caoutchouc bulb with valves. See also AQUAPULT; HYDRONETTE, *supra.*

Fig. 1957.

Plant Sprinkler.

Plaque. (*Ceramics.*) A decorated porcelain dish or plate.

Plas'ter. *Hard plaster:* Alum plaster, made in Paris for fine-polished walls. It does not, however, resist moisture thoroughly.

The gypsum in blocks is calcined in a reverberatory, cooled, placed in a wooden cage, and lowered into a bath with 10 per cent. of alum. After some minutes' immersion it is raised, allowed to drip into the bath, then laid on a floor to dry; again raised to a red-heat in a furnace, cooled, ground, and bolted.

Another plan is to mix the ground plaster with alum in powder and bake in a furnace.

See also STUCCO.

See plaster arch . . .	"*Scientific American*," xxxiv. 156.
Bronzing casts	page 139, *supra.*
Casts	"*Scientific Amer.*," xxxvii. 343.
Machine	"*Scientific American*," 194.
Casts, manufacture of .	"*Scientific Amer.*," xxxvii. 343.
Mill	* Bone Mill, Fig. 378, p. 119, *supra.*

See also CEMENT MILL, Fig. 575, p. 183, *supra.*

Paste, adhesive . . .	"*Scientific American Sup.*," 2764.
Tools	* "*Manufact. & Builder*," xi. 155.
Trowel	* p. 2631, "*Mech. Dict.*"

Prepared slabs nailed to studding or walls. — *Hitchins.* "*Iron Age*," xxi., Jan. 3, p. 16.

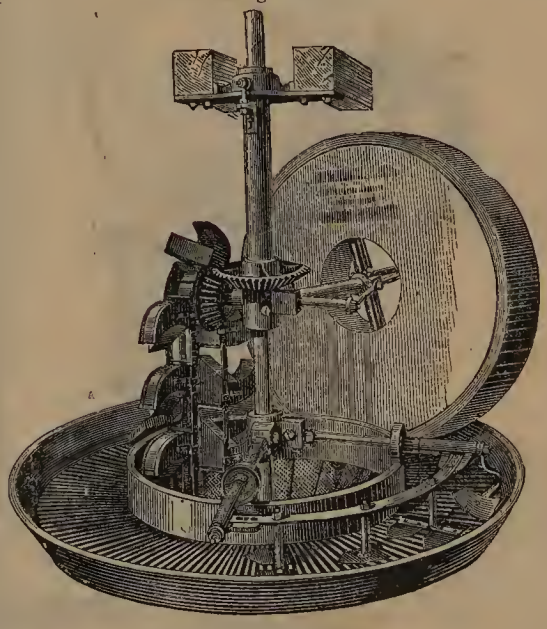
London "*Building News*," "*Sc. American*," xxxvii. 248.

See also BÉTON; CEMENT; MORTAR; PLASTER; STUCCO, "*Mech. Dict.*"

Plas'ter Mill. A machine in which crude plaster is ground to powder.

The form shown is by Jannot fils, Triel (*Seine et Oise*), Fr. It has the Chilian roller, followed by stirrers, scrapers, and hoes. The bottom of the annular trough is a grating,

Fig. 1958.



French Plaster Mill.

through which the powdered material passes. A series of cups on an endless band raise the material from a central well and discharge it into the trough.

See BONE MILL, Fig. 378, p. 119, *supra*; CEMENT MILL, Fig. 575, p. 183, *Ibid.*; MORTAR MILL, Fig. 2330, p. 1480, "*Mech. Dict.*"

Plas'tic Crys'tal. A variety of Portland cement remarkable for its plasticity, and consisting of —

Silica	86.42
Alumina	9.33
Oxide of iron	0.86
Lime	0.34
Magnesia	0.22
Alkalies	0.37
Loss on ignition	2.40
	99.94

"*Dingler's Polyt. Journal.*"

Plas'tic Etch'ing. (*Glass.*) The term given by Casset-Delas, of Paris, to his etched plate-glass. It is designed to give relief by etching away the glass, and to imitate plastic relief; basso, or *pâte sur pâte.*

Plas'ti-li'na. A kind of modeling clay, which

remains damp, and does not require frequent wetting.

Glycerine has been mixed with the clay, but the following composition is preferred: —

Fatty acids and fats	10
Oxide of zinc	1
Sulphur	6
Clay (dried and powdered)	3

Or: —

Glue	8
Oxide of zinc	1
Oleic oil	4
Wax	2
Sulphur	6
Clay	3

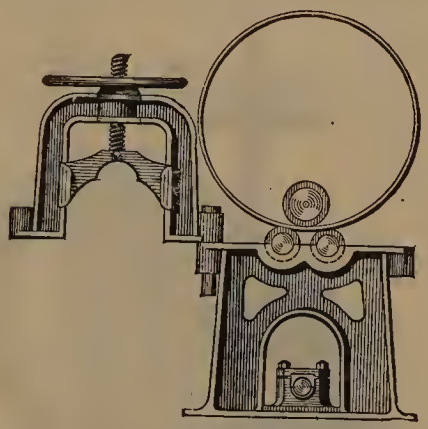
Plate. (*Fire-arm.*) The side of the lock.

Plate Bend'er. A round bitted pinchers, for bending dental plates without showing the pinch marks.

Plate Bend'ing Ma-chine'. Machines for bending plates are shown under several specific heads. ARMOR PLATE BENDING, Fig. 296, p. 97, *supra*, and refcrences *passim*.

In the plate-bending machine, Figs. 1959, 1960, the princi-

Fig. 1959.

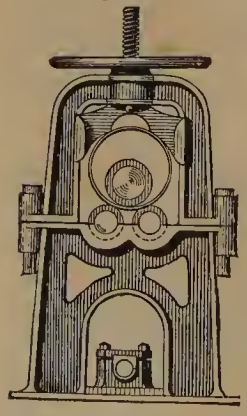


Bending Rollers (Arch Open).

pal feature of the invention is, that tubular work, such as flues, cross-tubes, funnels, ship-masts, etc., can easily be removed from the machine, after they have been formed into the requisite shape and size, *without requiring to unship any of* the rollers. The plan hitherto adopted has been to draw out the top roller when releasing tubular work, which arrangement involves the labor of re-shipping the roller before the machine can be used again.

The whole of the driving gear of this machine is arranged at *one* end, and is made either double or triple powered, in accordance with the size of the machine. The other end is entirely free from driving gear. The framing is made in halves, held together by cotter bolts. After a plate has been formed into an entire circle, one of the cotter bolts is removed, the top part of framing is swung round out of the way, when the tube is easily drawn out, and the framing can be instantly readjusted for the following operation.

Fig. 1960.



Bending Roller (Closed).

Plate Glass. History and procedure on pp. 1737, 1738, "*Mech. Dict.*"

Plate XXXIV. has a plan and elevation of a French plate-glass factory.

The furnace for 12 crucibles is elliptical in form. The *siege* or crucible platform is in a single mass of fire-clay concrete work, and has a central elliptical funnel-shaped crater, at the bottom of which is the grating, and beneath the latter is the ash-pit in the sub-way of the glass-house, by which air reaches the furnace. Twelve openings, of which the sills are on the level of the crucible *siege*, serve as means of introducing and removing the pots, and each is closed with a large tile, *tuile d'ouvreau*, when the melting process is in course. Above each of these large openings is a small one known as a *pigeonnier*, through which the materials to be melted are introduced into the pots by means of a square tray on the end of a long handle. The hole affords means of judging of the progress of the melt, and is closed with a ball of fire-clay. The flame strikes against the vaulted roof, circulates around the crucibles and escapes into the little chimneys perforated in the pillars of the wall and thence to the conical sheet-metal chimney *A*.

The furnace is placed in a central position between ovens, *leers*, *B*, in which the glass plates are annealed. *D D* are cranes by which the crucibles or cuvettes *E* are lifted and moved, to carry the molten glass from the furnace to the tables *C C*, where the molten glass is rolled to a thickness, depending upon the upward projection of the rim of the table on which the roller runs. The table has wheels which run on rails so as to present the glass at the opening of either one of the annealing furnaces in the series. Each *leer* has three furnaces to heat it, a large opening in front to enter and remove the glass plates, openings for air to gradually reduce the heat, and a flue to lead the fumes to the chimney. See, also, description on p. 1738, "*Mech. Dict.*"

Factory, Jefferson Co., Mo. "*Scientific Amer. Sup.*," 3796.
Manufacture in Pa. . . . "*Iron Age*," xix., June 14, p. 11.

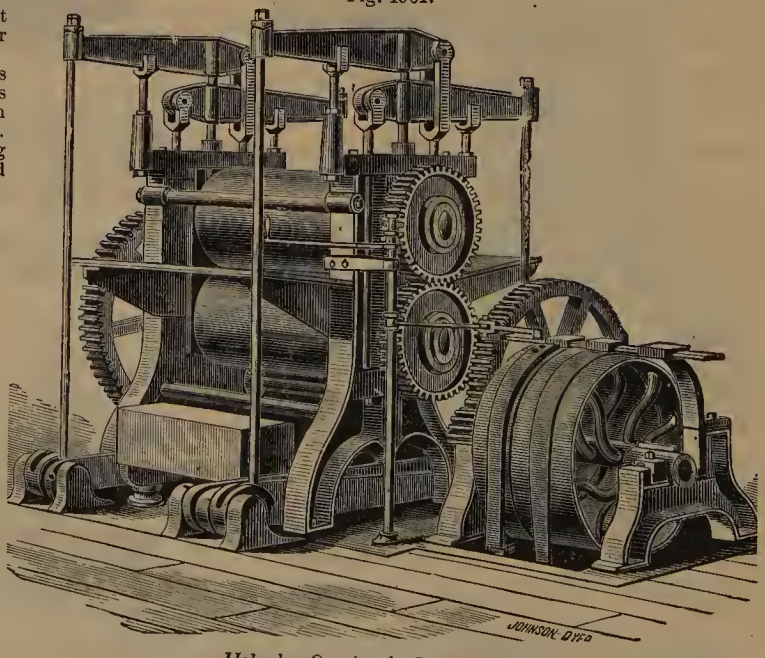
Plate Key. A flat key, notched at the ends or sides. The Yale key, for instance. See LOCK.

Plate Ma-chine'. One for making porcelain plates. The operation is — to speak more exactly — threefold, consisting in forming, molding, and turning. See PORCELAIN PLATE MAKING.

Plate Ma-chin'er-y.

See: Bending machine.
Bennie, Br. . . . . * "*Engineer*," xliv. 373.
Mill. See ROLLING MILL.
Pickling machine . . * "*Engineer*," xliii. 268.
Taylor, Br. . . . . * "*Scientific American Sup.*," 1185.

Fig. 1961.



Holyoke Quadruple Lever Plater.

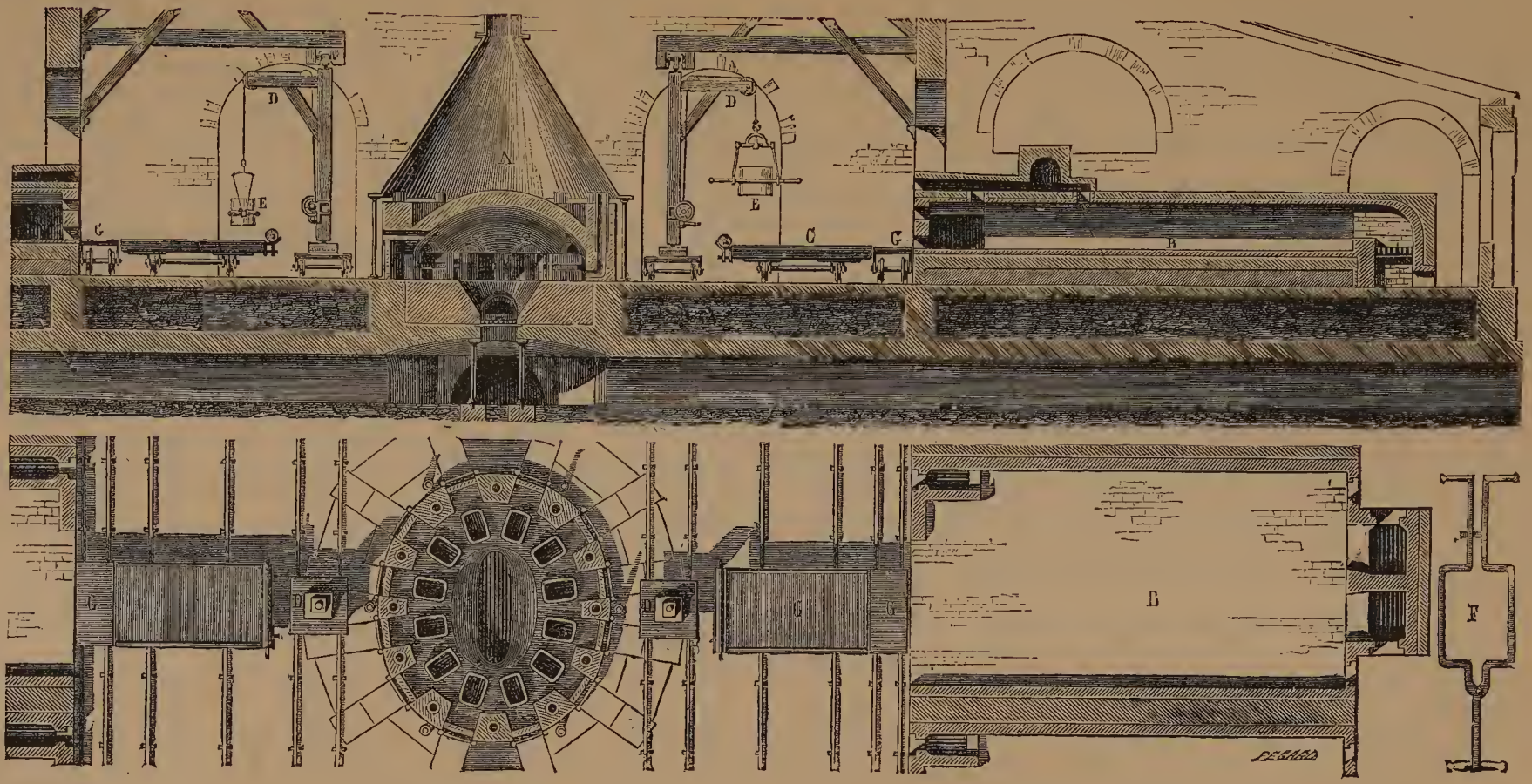


PLATE XXXIV. FRENCH PLATE-GLASS HOUSE. (*Sectional Elevation and Plan.*) *See page* 690.

Edge planing machine.
Asquith, Br. . . . . * "*Engineering*," xxix. 186.
Planing machine.
Bennie, Br. . . . . * "*Engineer*," xliv. 351.
Shears, boiler, *Johnson*. * "*Scientific Amer.*," xxxvii. 294.
Shearing mach., *Sellers* * "*Iron Age*," xviii., Aug. 24, p. 1.

Plat'en Gage. An attachment to a printing press for holding and guiding the paper. *Halleck.* * "*Scientific American*, xxxix. 338.

Plate Nip'pers. (*Dental.*) Nippers used in cutting out plate for dentures.

Plate Press. A copper or steel-plate press. Fig. 1445, p. 619, "*Mech. Dict.*"

Pla'ter. A paper calendering machine.

The weights and levers of the machine, Fig. 1961, exert a pressure of about 35 tons on the roll. The paper is packed between smooth plates of zinc or copper, and passed between the rolls back and forth till the desired finish is obtained: the motion of the machine being reversed at each passage of the pack.

Plate Shear'ing Ma-chine'. Examples are given under SHEARS in the "*Mech. Dict.*"

The Sellers plate-shearing machine, Fig. 1962, is specially adapted for cutting and trimming plates used in bridge and ship construction, and is adapted for trimming edges of long plates, or cutting off to length plates 5′ wide. Will shear wrought-iron plates 1″ thick. The upper blade is guided vertically in the frame of the machine, and driven down by a pitman as wide as the blade is long, this pitman receiving its motion from a long rocking shaft above it. The driving

Fig. 1962.

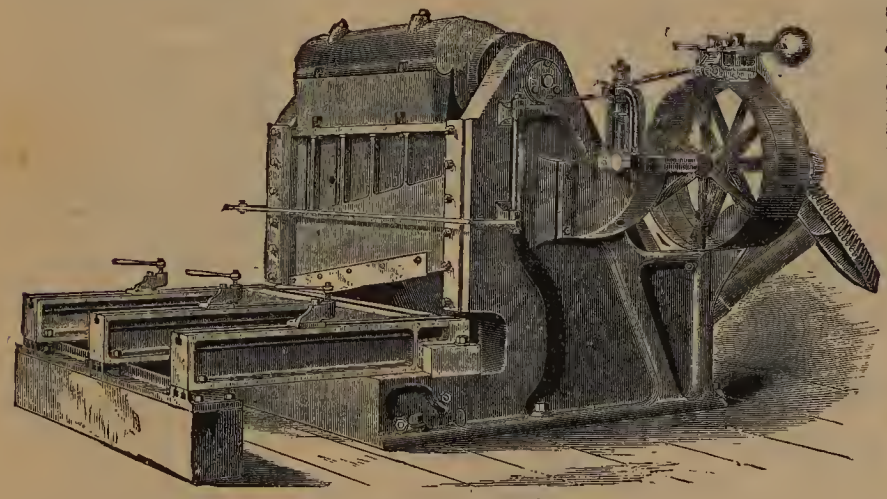


Plate Shearing Machine.

arm or lever of the machine is a rack segment engaging with the teeth of a spiral pinion, which is driven by bevel wheel and pinion and open and crossed belt, after the manner of planing machines. The cutting blade is adjustable in length of stroke, returning at double the speed of its down stroke.

The blade can be made to cut to any fixed point in its length and then stopped or raised. It is provided with an automatic adjustment to its belt-shifting motion, gaging the length of its stroke. It makes the down stroke, immediately reascends, and stops up, to wait for the readjustment of the plate.

Fisher's bevel-edge boiler and armor plate cutter is on an oblique frame so as to chamfer edge the plate presented to it. Of the jaws, one is horizontal and holds the plate, the other descends in an oblique direction and bevels the plate edge.

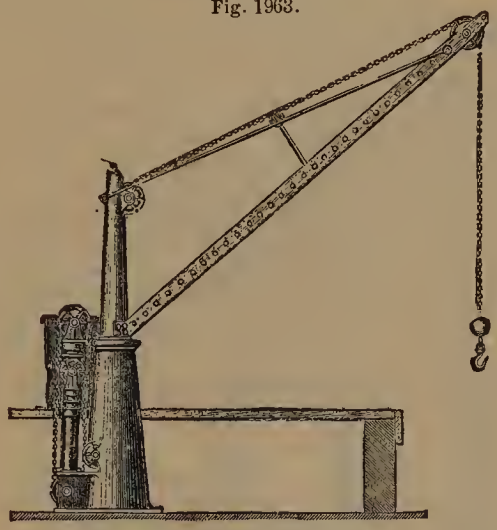
Plate Weld'ing Ham'mer. A peculiar form of steam hammer for welding plates, carried on the flat horn of a movable anvil beneath the hammer.

Adamson . . . . . * "*Engineering*," xxx. 295.

Plate Wheel. (*Railway.*) A car-wheel, the web of which is a plate, instead of spokes.

Plat'form. (*Railway.*) Miller's platform is used in conjunction with his automatic car coupler, and is arranged so that the line of draft and the compressive strains on the car are in a direct line with the sills of the latter.

Fig. 1963.



Hydraulic Platform Crane.

Plat'form Crane. A crane upon a landing platform for discharging goods, etc., from cars or wagons.

In the hydraulic platform crane, shown in Fig. 1963, the machinery is easily accessible. The mast and jib are supported in a heavy foundation. The pipes and hydraulic cylinder are independent of the jib, and the only stuffing-boxes or working hydraulic joints are the glands of the hydraulic ram and ram spindles.

Fig. 1964.

Platform Spring Shackle.

Plat'form El'e-va-tor. One lifting a platform or cage. See ELEVATOR.

Plat'form Spring. A form of spring, Fig. 1965, used largely on city trucks; the *platform* is probably the bed of the truck and gave its name to the spring.

Fig. 1965.

Platform Springs.

Fig. 1964 shows the peculiar shackle used in coupling together the springs, the ends of which meet at a right angle: as seen in the lower one of the four springs, Fig. 1965.

Plat'in-i-zing. (*Metals.*) The process of M. Dode, of Paris, is for the protection of the iron from the action of air, fire, and acid gases.

The iron first receives a coating composed of lead and copper, and then the platinum is applied. The first coating is prepared by mixing 22 parts of borate of lead and 4½ parts of cupric oxide in oil of turpentine, and is applied by means of a fine brush. The platinum coating is prepared by converting 10 parts of platinum into chloride mixed with 5 parts of ether, the latter being permitted to evaporate in the air. The residuum is mixed with a viscid combination of 20 parts borate of lead, 11 parts red lead, and some oil of lavender, and 50 parts of amylalcohol are added to the whole. Into this mixture the object to be platinized is dipped, allowed to dry in the air, and then heated to a moderate temperature.

"*Scientific American*" . . . . . xxxvi. 233, 407.
"*Scientific American Supplement*" . . 2818.

(*Glass.*) Platinum has been tried for a reflecting surface, but owing to the somber appearance of objects reflected by looking-glasses prepared with it, it has not met with a commercial success.

Pla-tin'o-type. A photographic print obtained upon paper in platinum in form of a finely-precipitated powder. In this state the metal possesses an intensely black color, and, as in its massive state, is wholly unalterable by atmospheric influences. — *Willis.*

"*Engineering & Mining Journal*" . . . . . xxvi. 333.
"*Scientific American Supplement*" . . . . . 2466.

Pla-ti'num. Article "*Platine*," *Laboulaye's* "*Dictionnaire des Arts et Manufactures*," iv., ed. 1877. *Deville & Debray* osmium crucible furnace,* platinum crucible,* Figs. 3684, 3685.

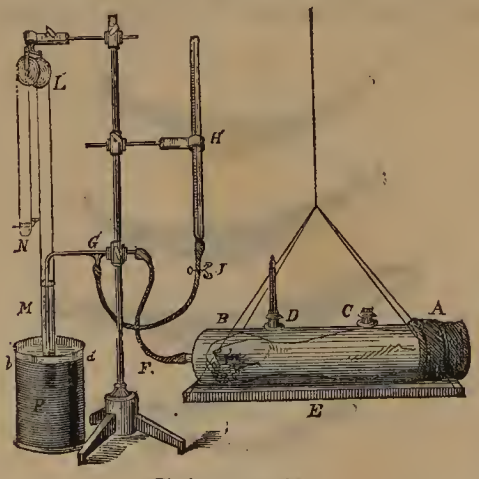
Platinum, iridium, palladium, etc., at Paris Expo. in 1878.
"*Engineering & Mining Journal*" . . xxvi. 147, 164.
"*Paris Exposition* (1878) *Reports*" . . iv., p. 65 *et seq.*

A platinum alloy, melted and cast by Matthey, of London, "is so malleable and ductile that thread 1-2500th" in diameter has been made of it. Its composition is: Platinum, 80.660 per cent.; iridium, 19.079 per cent.; rhodium, 0.122 per cent.; iron, 0.098 per cent.; and ruthenium, 0.046 per cent. Its density at a temperature of 32° F., is 21.614." — *Phillips.*

Ple-thys'mo-graph'. An instrument invented by Sig. Mosso, of Turin, for observing the variation of the circulation of blood in various parts of the body under natural or artificial causes: as in the two arms; the acceleration in the head in case of surprise, etc.

The forearm, for instance, is inserted in a glass cylinder, *B*, which rests on suspended plank *E*, and is filled with tepid water, a rubber ring, *A*, preventing the exit of water around the arm. There is an opening, *F*, leading from the cylinder to a measuring apparatus, *C*, which indicates the quantity of water admitted or expelled by the contraction or dilation of the volume of the forearm, due to the arterial action. See also SPHYGMOGRAPH.

Fig. 1936.



Plethysmograph.

The test tube *M* is equilibrated by the counterweight *N* and pulley *L*; *D* is a thermometer.

"*English Mechanic*" . . . . . xxvi. 392.
"*Scientific American*" . . . . . * xxxiv. 403.

Pli-ca'tor. A mechanical device for making a plait or fold, as in some sewing-machine attachments, for instance. U. S. Patent, No. 229,479.

Plow. See the following varieties, and apparatus connected therewith: —

Adjustable beam plow.
Anchor.
Anti-friction plow.
Balance plow.
Beet root digger.
Bisoc.
Black-land plow.
Blade.
Brabant plow.
Breaker.
Brush plow.
Car unloading plow.
Chain harrow.
Chilled plow.
Colter.
Combination plow.
Corn plow.
Cotton cultivator.
Cotton plow.
Cotton scraper.
Cotton sweep.
Cultivator.
Cultivator plow.
Cutter.
Disk harrow.
Disking machine.
Ditching machine.
Ditching plow.
Double furrow plow.
Double mold-board plow.
Double plow.
Double shovel plow.
Double turning mold-board plow.
Draft chain.
Draft rod.
Drag.
Draining plow.
Duck's foot cultivator.
Expanding cultivator.
Fore carriage.
Gage wheel.
Gang plow.
Geddes harrow
Grubber.
Half-shovel plow.
Harrow.
Harrow cultivator.
Hillside plow.
Hoe.
Hoeing machine.
Horse hoe.
Jointer.
Jointer plow.
Leveling plow.
Listing plow.
Marker.
Mold board.
Mole plow.
Movable point plow.
Multifurrow plow.
One-horse plow
Parer.
Paring plow.
Plow feuder.
Plow holder.
Pony plow
Porter.
Potato coverer.
Potato digger.
Potato planter.
Prairie breaker.
Prairie plow.
Prairie renovator.
Railway plow.
Reclamation plow.
Ridge harrow.
Ridging plow.
Riding cultivator.
Road grader.
Road plow.
Rolling colter plow
Rolling mold plow.
Rotary plow.
Row marker.
Scarifier.
Scraper.
Seeding plow.
Share.
Share harrow.
Shovel plow.
Single shovel plow.
Skin colter plow.
Slip share.
Snow plow.
Sod plow.
Steam plow.
Steam-plowing engine.
Subsoiler.
Subsoil plow.
Sugar-land plow.
Sulky cultivator.
Sulky plow.
Sweep.
Sweet-potato digger.
Swing plow.
Swivel plow.
Three-furrow plow.
Three-horse cultivator.
Tongueless cultivator.
Tourne oreille.
Trenching plow.
Triple gang plow.
Triple plow.
Triple shovel plow.
Turning cultivator.
Turning mold-board plow.
Turn-wrest plow.
Two-furrow plow.
Vineyard bisoc.
Vineyard cultivator.
Vineyard harrow.
Vineyard plow.
Walking cultivator.
Walk scraper.
Weeding hoe.
Wheel hoe.
Wheel plow.
Windlass.
Wooden mold-board plow.

In plowing with dynamite a certain number of dynamite cartridges are buried at regular distances in the soil, and connected together by electric wires. The explosion is simultaneous; and, though nothing is thrown up, the field is effectually plowed.

The Sackett plow and pulverizer throws the soil into a cage which rotates at the side of the plow, and so pulverizes the soil.

Plows of all nations. "*Scientific American Sup.*," 2249.
Knight . . . . . "*N. Y. Tribune*," Aug. 20, 1878.
Early Br., etc. (40 Figs.) * "*Engineer*," xlviii. 26, 43, 72.
In Gt. Britain, notes on early plows . . . . "*Engineering*," xxvii. 534.
Daniel Webster's . . . * "*Scientific American*," xxxv. 323.
Plowing with dynamite "*Scientific Amer.*," xxxvi. 262.

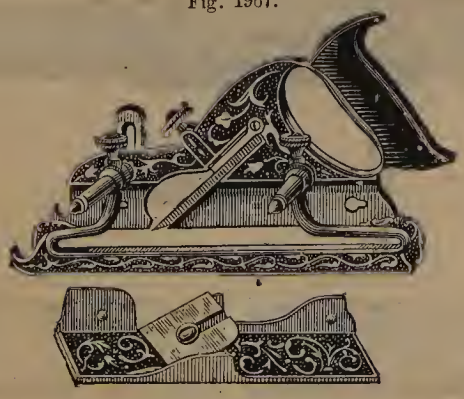
Electric, *Chrétien & Felix*, Fr.	*	"*Engineer*," xlvii. 434.
Felix, Fr.		"*Scientific American Sup.*," 3791.
		"*Scientific American*," xli. 41.
Plow engine, *Burrell*, Br.	*	"*Engineer*," l. 44.
Howard, Br.	*	"*Engineer*," l. 61.
Fowler	*	"*Engineer*," l. 68.
Burrell, Br.	*	"*Engineer*," xliv. 262.
Everitt & Adams, Br.	*	"*Engineering*," xxviii. 218.
Iron		"*Scientific Amer.*," xxxvi. 164.
At French Expo. trials, 1878	*	"*Scienifitc Amer.*," xxxix. 162.
Paris, rude plows at		"*Scientific American Sup.*," 2142.
French	*	"*Scientific American Sup.*," 2601.
Ridging	*	"*Scientific Amer.*," xxxix. 164.
Kilburn show, 1879 (20 Figs.), Br.	*	"*Engineer*," xlviii. 25, 43, 72, 284, 356.
Large "Great Western," Cal.		"*Min. & Sc. Press*," xxxvii. 87.
Rotary mold		"*Scientific American*," xxxvii. 66.
Railway ditch, *Deere*	*	"*Scientific American*," xl. 294.

The report of *Dr. E. H. Knight* on Class 76, at the Paris Exposition, of 1878, contains views and descriptions of the following varieties of plows ("*Paris Exposition Reports*," v., p. 1, *et seq.*): —

Wooden mold-board plow	France.
Charrue à chaine	France.
Plow mounted with avant-train	France.
Brabant simple	France.
One-wheeled plow	France.
Large two-wheeled plow, with jointer	France.
Two-wheeled plow	England.
"Bridle" pattern wheel-plow	England.
Revolving mold-board plow	England.
Michigan rod-beam plow	U. S.
Movable-point plow	France.
Single plow	France.
Iron-beam plow	U. S.
Center-lever plow	U. S.
Reese combination plow	U. S.
Tourne-oreille	France.
Tourne-oreille, shifting socket-piece	France.
Turning mold-board plow	France.
Hillside plow	U. S
Brabant double plow	France.
Brabant double plow, with skim-colter	France.
Brabant double plow, with subsoil talons	France.
Brabant double plow, with skim-shares	France.
Skim-shares	France.
Subsoil plow	France.
Brabant subsoil plow	France.
Sayn's scarifier	France.
Mole plow	France.
Draining plow	France.
Trenching plow	France.
Ridging plow	France.
Clearing plow	France.
Gilpin's sulky plow; *Deere & Co.*, Moline	U. S.
Bisoc	France.
Gang plow	U. S.
Double-furrow plow	England.
Bisoc double	France.
Charrue à trois socs	France.
Three-furrow plow	France.
Leveliug implement, with 5 plows	France.

2. (*Joiners.*) A grooving plane, with adjustable fence to regulate the distance of the groove from the working edge.

Fig. 1967.



Combination Plow and Fillister.

The tool shown in Fig. 1967 embraces a combination of the carpenter's plow, an adjustable fillister, and a matching plane.

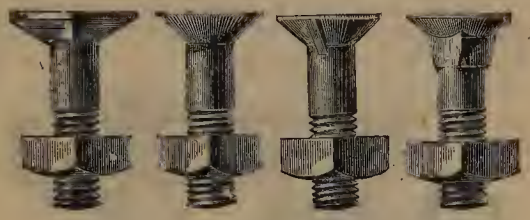
The engraving represents the stock of the tool, adjusted for use as a plow.

A metallic bed-piece, with cutter, can be attached to the stock of the tool by means of two screws passing through the slots in the base-piece of the stock. Over this bed-piece the gage, or fence, will move backward or forward, and when secured to the bars by the thumb-screw will constitute an adjustable fillister of any width required.

See also DADO; FILLISTER, "*Mech. Dict.*"

Plow Bolt. A bolt for securing the share, landside, or mold-board to the stock. It has a

Fig. 1968.



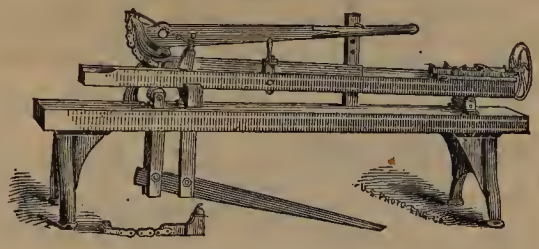
Plow Bolts.

chamfered countersunk head, and usually a square or fin to keep it from turning when the nut is screwed on.

Plow Grind'er. An emery machine specially adapted for grinding the faces of shares, mold-boards, and landsides.

Plow-han'dle Bend'ing Ma-chine'. A machine adapted for bending plow-handles after they are turned. The handle is steamed, it is locked to

Fig. 1969.



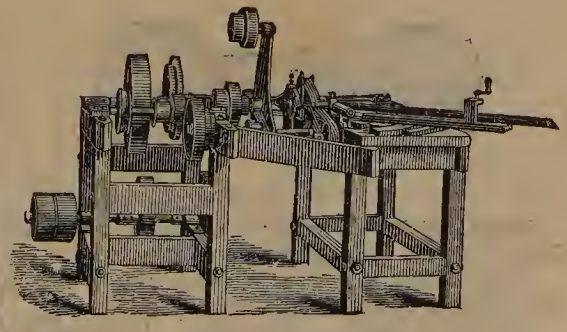
Plow-handle Bending Machine.

the bed of the machine, the grip-end attached to the lever, which is then brought down, bending the handle by means of a flexible chain on the outside. The end of the handle is then fastened by a rod to a cramp on the straight portion of the same, and the piece removed to season in drying.

See also WOOD-BENDING MACHINES, pp. 2803, 2804, "*Mech. Dict.*"

Plow-han'dle Pol'ish-ing Ma-chine'. A

Fig. 1970.



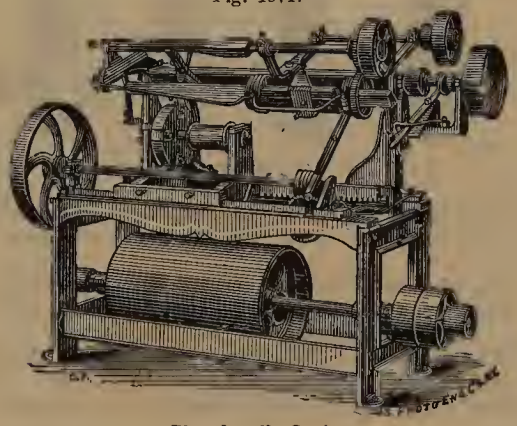
Plow-handle Polishing Machine.

machine for polishing or smoothing plow-handles after they are bent and sufficiently seasoned. It has a central shaft on which is a cast-iron frame, with pulleys and a smoothing belt. It is automatic. The handle is put in position and fastened, the feed is thrown in by the lever, which causes the frame with the polishing belt to revolve around the handle; at the same time the carriage holding the handle feeds slowly along until the bent or rounded part of the handle is finished, at which point it throws out the feed.

Plow-han'dle Lathe. A machine on the principles of the Blanchard lathe, adapted to turn plow-handles by patterns.

In the case represented the pattern-rest is adjustable so that it will turn different sizes from the same pattern without readjustment of the machine. The cutter head is so arranged and constructed that it reduces the stuff worked with great ease, leaving it in a smooth condition; it runs in a movable carriage, is automatic in its operation, and is protected by an iron cover from accident.

Fig. 1971.



Plow-handle Lathe.

Plow'ing Ma-chine'. See *Steam Plow, pp. 2354-2356, "*Mech Dict.*"

Knight's report of Group 76, "*Paris Exposition* (1878) *Reports,*" v., pp. 53-89.

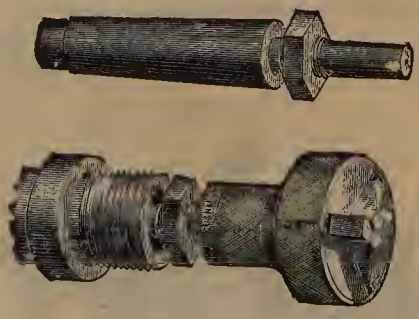
Plug. 1. A tap, made of a form intermediate. *Taper, plug, bottoming,* see Fig. 6211, p. 2495, "*Mech Dict.*"

2. A stopper screwed into the end of a pipe.

3. A short rod, split lengthwise, and the sections driven apart by a wedge known as a *feather;* for riving stone, Fig. 3834, p. 1749, "*Mech. Dict.*"

Plug Ar'bor. A lathe attachment for mounting drill chucks. *Cushman,* Fig. 1972.

Fig. 1972.



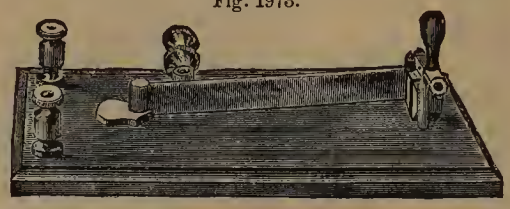
Plug Arbor.

Plug Ba'sin. A standing washbowl with plug hole at bottom for emptying.

Plug Cock. A faucet which is simply driven into the barrel, not screwed in.

Plug Cut'-out. (*Telegraphy.*) Or *wedge cut-out;* a spring connected to one main-line binding-post, normally rests against a pin connected with the other main-line binding-post, thereby forming a spring-jack into which a wedge-shaped switch loop-plug may be inserted for the purpose of connecting instruments in line without disturbing the continuity of the circuit. A set-screw bearing against the side of the spring is used for adjusting its tension.

Fig. 1973.



Plug Cut-out.

Plug Fin'ish-er. (*Dentistry.*) A fine file for finishing the surfaces of tooth fillings.

Fig. 1974

Plug Finishers.

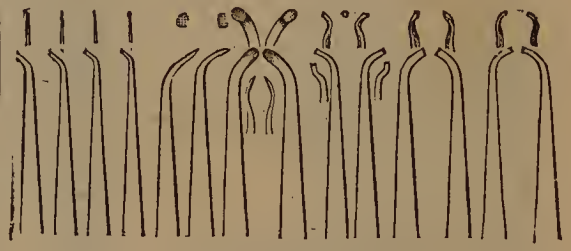
The sizes, shapes, and fineness of tooth, fit the instruments for special applications. Some are file-cut on one side and some on both.

See Dental File, Fig. 796, p. 251, *supra.*

Plug'ger. (*Dentistry.*) A tool for driving and packing filling materials into carious and excavated teeth.

Fig. 1975 shows a number of hand pluggers of various forms.

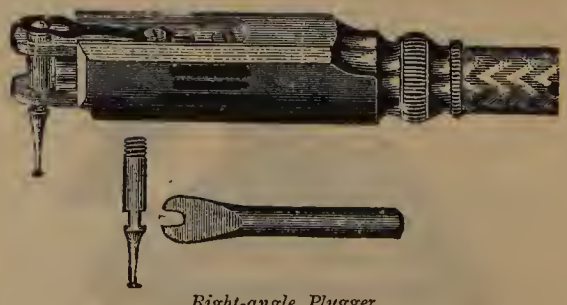
Fig. 1975.



Hand Pressure Pluggers.

Fig. 1976 shows a right-angled plugger to be used on a machine.

Fig. 1976.



Right-angle Plugger.

See also Dental Hammer, "*Mech. Dict.*"; Dental Plugger Spring, Figs. 3835, 3836, p. 1749, *Ibid.*; Dental Plugger, electro-mag., Fig. 3827, p. 1750, *Ibid.*

Plug'ging Mal'let. A mallet for dental operations.

The heads are *lignum vitæ*, soft steel, wood with metal core. See DENTAL MALLET, p. 251, *supra*.

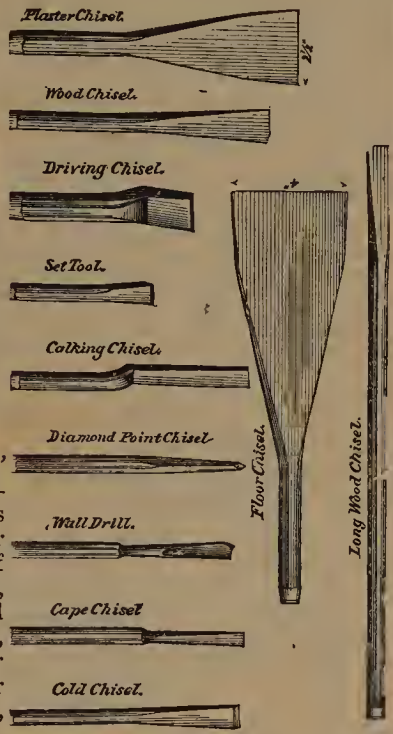
Plug Tap. One somewhat tapered at the end to facilitate its entrance in commencing to tap a hole. See PLUG, *supra*.

Plumb. The suspending string is wound upon a reel concealed in the interior, and the friction of the reel will keep the bob suspended at any point. On release of the cord it rewinds.

Fig. 1977.

Plumb Bob.

Fig. 1978.

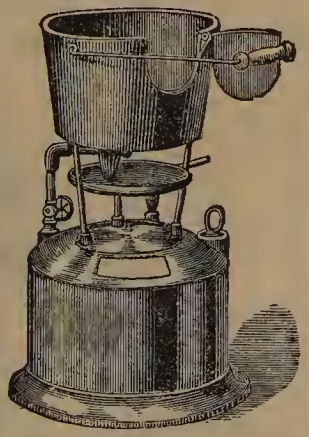


Plumbers' Chisels

Plumb'ers' Chis'els. Various lengths and widths, for cutting walls of brick, plaster, and wood; cold chisels for iron, long chisels for boring holes for pipes or wires, etc.

Plumb'ers' Fur'nace. A portable soldering furnace. That shown is heated with petroleum elevated from the reservoir below and burned in the tray. The handle forms a rest for soldering bits.

Fig. 1979.



Plumbers' Furnace.

Plumb'er's Tools. See list under PIPES, etc., *supra*.

Plun'ger. (*Fire-arm.*) *a.* A pin struck by the hammer and exploding the priming by force of the communicated blow.

b. In other cases the plunger has the exploding point on its own end, as in the bolt gun.

Plun'ging Bat'tery. (*Electricity.*) One in which the positive or the positive and negative elements may be withdrawn from the fluid to render the battery inoperative, or to prevent the consumption of the plates when the battery is not required.

Grenet's bichromate battery is a familiar instance. *Prescott's* "*Electricity*," * p. 72.

c c', Fig. 2148, p. 938, "*Mech. Dict.*," is an early form of plunging battery used by Sir Humphrey Davy.

See also Fig. 14, p. 2490, * "*Scientific American Sup.*"

It may be added that there are three principal modes: —

1. By plunging the elements into the liquid.

2. By raising the trough so that the liquid surrounds the elements.

3. By displacement of the liquid, raising it to the level of the elements.

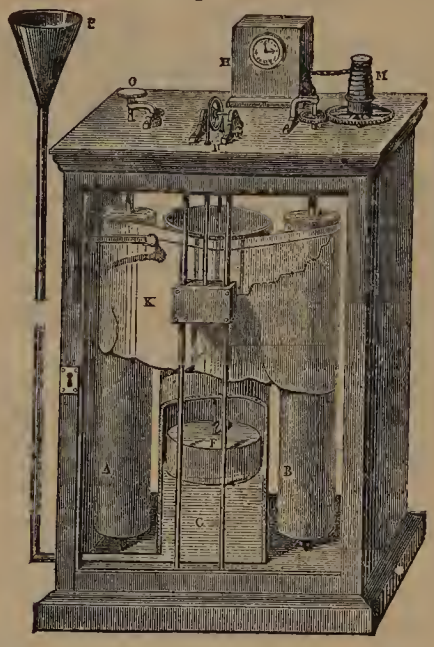
Plush. (*Fabric.*) The fabric known as *furniture plush* is a mohair fabric known also as *Utrecht velvet*. It is of mohair filling with cotton warp, or, in the better qualities, of mohair entirely. See MOHAIR.

Plush Bat'te-ry. A modification of the Callaud. Fr., * "*Engineer*," xlvii. 333.

Plu'vi-am'e-ter. An instrument used to measure the quantity of rain which falls over a given surface.

A new apparatus by M. Hervé Mangon is shown in Fig. 1980. A cylinder, *C*, receives the rain water led from the receiver *P*. In the cylinder is a copper float *F*, which, by means of a very fine cord passing over the pulley *N*, is connected to the weight *K* which is a little the heavier. The weight *K* slides on two guides of tightly stretched pianoforte wire, and carries a pencil, the point of which comes in contact with the

Fig 1980.



Pluviameter.

exterior of the cylinder *C*. Inside the weight *K*, which is hollow, is a small electric interrupter, which, whenever a current is transmitted to it from the regulator, strikes against the pencil and produces indicated points on a curve, which serves to control the clock movement by which are actuated the two copper cylinders *A* and *B*. Over these last a belt of paper is passed, as shown; and the mechanism in *H*, which moves them, is provided with a regulating fusee *M*, so as to compensate for the difference caused in the diameter of the cylinder *B*, by the rolling thereon of several thicknesses of paper. *I* is a fixed pencil which traces a horizontal base-line on the paper. The latter, after first being rolled about the cylinder *A*, is carried over cylinder *C* and attached to cylinder *B*. In the middle cylinder sufficient water is then introduced to completely buoy up the float *F*. If rain falls, the float, by the addition of water beneath it, is lifted; and the weight *K* following the movement, the pencil thereon traces a curve on the paper, which gives in millimeters the corresponding depth of rain. If, on the contrary, no rain falls, the line left by the weight pencil is straight and parallel to that made by the fixed pencil.

Lysimeter	p. 365, *supra*.
Pluviameter, *Mangon* .	* "*Scientific American*," xxxiv, 150.
Pluviametrograph, *Salleron*	*Laboulaye's* "*Dict.*," iv., Fig. 16, cap. "*Météorographe*."
Pluviascope, *Mangon* .	*Ibid.*, same article.
Rain gage	Fig. 4146, pp. 1872-1874, "*Mech. Dict.*"

Ply. 1. A web — as of a carpet. *Two ply* means two webs, woven together so as to interchange yarns at the points required to bring a

color to the surface in accordance with the pattern.

2. When the union of the two webs or plies occurs is the *ingrain*, which gives the name to this description of carpet.

Pneu-mat'ic Bat'te-ry. (*Electricity.*) One in which a blast of air is introduced to agitate the exciting liquids, and depolarize the elements. *Dr. Byrne's* is an instance. See AERATED BATTERY; BYRNE BATTERY.

Also . . . * "*Telegraphic Journal*," vi. 222, 269.
* "*Engineer*," xlv. 279, 496.
"*Scientific American Supplement*," 1922.
* "*Engineering*," xxv. 417.
* "*English Mechanic*," xxvii. 307.
"*Scientific American*," xxxviii. 228.
Paper by Preece * "*Jour. Soc. Tel. Eng.*," vii. 60; 82.

Pneu-mat'ic Clock. A clock which is driven or regulated by air.

In the Parisian system, handsome public illuminated timepieces have been erected in the middle of the causeway of the leading thoroughfares of Paris. These are all in communication with the works of the new Pneumatic Clock Company, in the Rue St. Anne. By means of subterraneau tubes this company receives the time direct from the Observatoire every morning, and regulates all the timepieces in connection simultaneously. In future it will be possible to have the correct time laid on in any house, like gas or water, at the trifling cost of from three to five centimes per clock per day.

To supply the whole of Paris, three or four central clocks are required, designated *Directing Normal Clocks*. These are placed at convenient centers, and connect with the ordinary or "Reception Clocks" of their system or district. Each of these central clocks is connected with a system of pipes, including, first, those running through principal streets; next, those branching therefrom into the minor streets; next, those running from the streets into the buildings; and, finally, smaller ones running as required in the interior of the buildings.

The central clocks are provided with a small engine, worked by steam or gas, which every minute sends a pulsation of compressed air through the entire system of pipes and acts upon every clock in the circuit, advancing the hands on the dial of the clock by one minute. The clocks are of simple construction.

See: . . . . . * "*Scientific American*," xliii. 19; * xxxix. 207; xli. 5.
Paris . . . . . * "*Manufact. & Builder*," xii. 217.
Vienna . . . . . * "*Engineer*," xliii. 448.
* "*Scientific American Sup.*," 1331.
Regulator, *Mayhridge* . * "*Scientific American*," xl. 130.
Regulator, *Wenzell* . . * "*Min. & Sc. Press*," xxxviii. 281.

Pneu-mat'ic Con-duct'or. A fan blower and tube, to lead away air, foul air, fire damp, fumes, smoke, dust, shavings, etc.

Such are used in connection with stones which grind dry, such as in some departments of cutlery.

Shavings from a planing mill in Chicago are driven by air blast 700′ through a 15″ sheet-iron pipe to a distillery, where they are burned.

See SHAVINGS CONDUCTOR, p. 2134, "*Mech. Dict.*"; FAN BLOWER, Fig. 1918, p. 825, *Ibid.*

Pneu-mat'ic Dis-patch'. A mode of conveying letters, parcels, etc., by sending them through a tube by force of air; vacuum or plenum systems. See PNEUMATIC TUBE.

Pneu-mat'ic Ex'ca-va'tor. A method of raising of sand, silt, or debris from a shaft in course of excavation.

Several forms are given in the "*Mech. Dict.*" under PNEUMATIC CAISSON, p. 1752; PNEUMATIC PILE, p. 1754; CAISSON, p. 421; AIR LOCK, p. 49, and Plate II.; SUBMARINE EXCAVATOR, Fig. 6028, p. 2439, etc.

The methods vary: 1. In the *Potts* system, the pile is a tube with the top closed, and the air being exhausted from within, the atmospheric pressure drives the cylinder into the sand. Used on the Goodwin Sands, England.

2. In the *Triger* system, the workmen are in the lower end of the chamber, and communicate with the exterior by air locks. See AIR LOCK, "*Mech Dict.*," p. 49. The system was used in sinking the caissons of the St. Louis and Brooklyn bridges. See references above quoted.

3. A mode of moving silt, mud, or sand by a pipe, the open end of which is exposed to the matter to be moved, and the air exhausted from the pipe. A vacuum system; a form of dredging apparatus.

4. The converse of the last mentioned; a pipe with blast of air, carrying with it detritus, silt, sand. Used in removing the matters from the caissons of the Brooklyn and St. Louis Bridges. See AIR LOCK, "*Mech. Dict.*;" PILE DRIVING, *supra*.

A form of pneumatic excavator which comes under the first cited of the four methods, is used in British harbor improvements.

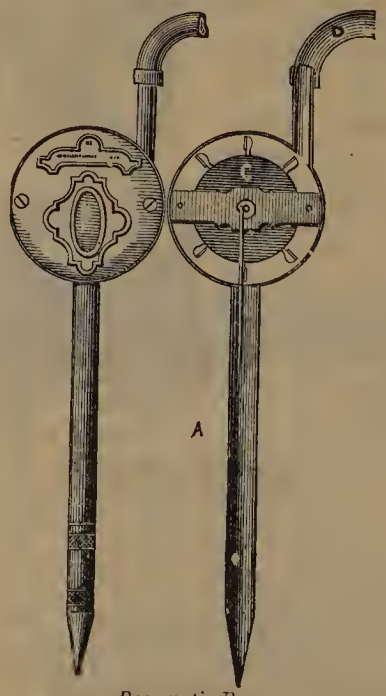
It is chiefly used for sinking the cylinders for the piers of bridges in sandy soil. The apparatus consists of a pair of cast-iron cylinders 4′ in diameter, carried on a staging and placed in connection at their tops with an air-pump, driven by a small steam engine. The connections are so arranged that the air can be exhausted either from one cylinder singly or both at the same time. The bottoms of the cylinders are connected with a suction tube 3½″ in diameter, which leads down to the sand. Here again it is so arranged that the cylinders can be worked, either singly or in combination, by means of self-acting valves. The soil is discharged from each cylinder by a trap door placed in its front. The engine and air-pump are carried on the same framing, and the whole forms a very compact arrangement.

In operation, the engine being started, the air is exhausted from one cylinder; the sand and soil rushing up into the vacuum thus created soon fill the cylinder, the fact being indicated by a tell-tale. The connection is then made between the air-pump and the second cylinder, and that is similarly filled, during which time the contents of the first cylinder are discharged, and it is ready for the air-pump by the time the second cylinder is full, and so the process continues alternately until the desired end has been attained. The excavator has worked very successfully; a vacuum of 24″ was maintained during exhaustion, and the cylinders were rapidly filled with sand and water from a pit, the contents being quickly discharged.

Pneu-mat'ic Ma-chin'er-y. See AIR ENGINES, and list under AIR APPARATUS, p. 12, *supra*.

Also: Elevator . . . "*Scientific American Sup.*," 2889.
Grain elevator . . . . * "*Scientific American Sup.*," 2107.
Hoist in mines . . . "*Iron Age*," xxii., July 11, p. 9.
"*Scientific Amer.*," xxxvi. 403.
"*Scientific American Sup.*," 2324.
Épinac colliery, Fr. . * "*Min. & Sc. Press*," xxxv. 147.
Excavator, *Reeve*, Br. . * "*Engineer*," xliv. 99.
Mining appliances . . "*Scientific Amer.*," xxxix. 260.
Ore stamp . . . . . * "*Scientific American Sup.*," 1058.
Pen . . . . . * "*Scientific American Sup.*," 774.
Pile driving . . . . * "*Scientific American Sup.*," 3769.
Rock borer (Minera, N. Wales) . . . . . * "*Scientific American Sup.*," 1461.
Railway, London . . . * "*Scientific American Sup.*," 1529.
Screw ventilator . . . *Laboulaye's* "*Dict.*," iii., cap. "*Ventilation*," Fig. 7.
Signal, *Chambers* . . . * "*Railroad Gazette*," xxiii. 55.

Fig. 1981.



Pneumatic Pen.

Pneu-mat'ic Pen. An instrument for obtaining a stencil for copying purposes. Fig. 1981. Numerous perforations are made through the paper by the instrument which follows the lines of the letters. See ELECTRIC PEN.

The instrument is guided as an ordinary pen. The tube *A* contains the needle *B*, which is connected to a crank on the axis of the fan-wheel *C*. Rapid motion is imparted to the fan by means of a blast of air either from the mouth of the writer or an air-bellows, through the flexible rubber tube *D*, connected with a foot-bellows or otherwise. On moving the point of the pen over a sheet of paper, it becomes pierced with very fine holes in lines of the desired pattern. Ink or color is then spread over the surface, which fills the holes, and passes through the stencil to as many sheets of paper as may be brought successively in contact with it.

Pneu-mat'ic Pile. See PILE DRIVING, *supra*.

Pneu-mat'ic Pile Dri'ver. See * PNEUMATIC PILE, p. 1754, "*Mech. Dict.*"; PNEUMATIC EXCAVATOR, *supra*; see also PILE, *supra*, and * "*Scientific American Supplement*," 3769.

Pneu-mat'ic Pump. A pump in which the pressure of air upon a liquid is made the means of forcing or elevating. An application of the air pump.

The pump shown in Fig. 1982 is used for the discharge of the contents of casks, carboys, etc. It is a caoutchouc bulb

Fig. 1982.

Pneumatic Pump.

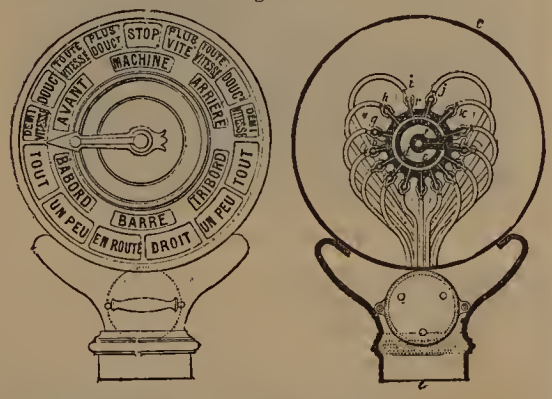
with valves. The pipe passes through the bung of the cask and condenses the air above the liquid in the latter. The liquid passes out by another pipe to the vessel placed to receive it.

Pneu-mat'ic Tel'e-graph. The pneumatic telegraph of Count Sparre, of Sweden, is shown and described on p. 1755, "*Mech. Dict.*" It acts by the impulse given to a column of water by pneumatic pressure.

Under PNEUMATIC CLOCK, *supra*, is described the method of running all the clocks of a district by means of an impulse of air, at definite intervals, carried by pipes to each clock in the district, and moving the hand on the dial one step.

The *télégraphe à air* of M. Walcker, of Paris, is shown in Figs. 1983–1986, as applied to the vessels of the French navy and transatlantic service.

Fig. 1983.



Pneumatic Telegraph Transmitter. (*Engine and Compass.*)

Fig. 1983 gives two views of the transmitter, — a front elevation and a vertical section on the same plane, a little behind the dial, on the line *a b*, Fig. 1985.

Fig. 1984.

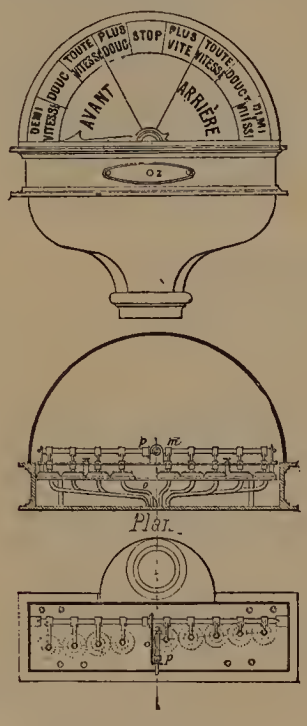
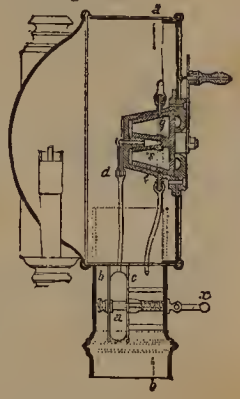
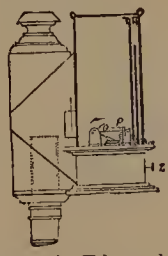


Fig. 1985.



Pneumatic Telegraph Transmitter. (*Transverse Section.*)

Fig. 1986.



Pneumatic Telegraph Receiver. (*Engine.*)

Pneumatic Telegraph Receiver. (*Transverse Section.*)

Fig. 1984 has three views of the receiver, — a front elevation, a vertical section in the rear of the dial exposing the machinery, and a horizontal section giving a plan of the acting parts.

Fig. 1985 is a vertical section on a plane transverse to the former.

Fig. 1983 is a vertical transverse section of the receiver.

The purpose of the apparatus is to convey to the engineer and to the steersman the directions of the captain or pilot on the bridge of the steamer.

The apparatus is double or single; in the former case, the dial has a full circle, the upper hemisphere concerns the engine, and the lower portion the rudder. In the single apparatus the engine or the rudder is alone concerned, — one single transmitting apparatus for each being placed on the bridge.

The operation of the apparatus is by compressed air, caused by a pressure brought upon the caoutchouc reservoir *a*, which is compressed between plates *b c* when the piston *x* is pulled. Air escapes to the chamber *d* and thence to passages *e f*, which, by devices to be described, sound a bell and move a pointer respectively in the receiver, which may be in the engine-room or the wheelhouse, as the case may be.

The operation is as follows: The needle being at zero, in the horizontal position shown in Fig. 1983, and the vessel supposed to be on her course, the officer on the bridge wishing to stop the engines, takes hold of the pointer (the handle is seen projecting to the right in Fig. 1985), and moves it to "*stop*," at the same time pulling the piston *x* and compressing the air in *a*. There are as many pipes to convey the air from the transmitter to the receiver as there are directions; for the engineer there are 9, — 1 for "*stop*" and 4 each for graduations of speed in "*forward*," "*astern*," respectively. In the example cited, "*stop*," the air passes in two bodies, one to the bell in the engine-room which calls the alarm, and the other by the special pipe which actuates the needle in the receiver, Fig. 1985, to bring it from its horizontal (zero) position to "*stop*" on the dial. The position of the pointer on the transmitter governs the choice of pipe openings, which are shown in a circular series in the sectional view Fig. 1983. The transverse section, Fig. 1985, shows the lamp at the rear which illuminates the glass dial on which the various indications are pointed.

The receiver is shown in Figs. 1984, 1986. It requires but a half-dial to hold its indications, and is but a single machine which belongs to the engine room. The fellow machine, which responds to the other half of the transmitter, is in the wheel-house. Taking the receiver in the engine-room: the pointer, when at zero, is horizontal, and the ac-

tion of the air is to cause it to make a sweep within the range of a semicircle. The 9 air-tubes from the transmitter lead to as many levers in the receiver. As the levers are of different lengths an equal motion of the end of each will have a corresponding effect upon the axis *m*, with which they are connected, and upon the level gear *p* which actuates the needle. Thus the latter is moved less or more to bring it to the required place on the dial, which, in the example cited, "*stop*," is midway, that is, vertical. It stays at its indication until the engineer pulls on the button *z* and releases the air. The engineer then calls "*Aye, aye, sir*" through an acoustic tube. The same description, *mutatis mutandis*, applies to the steering.

Pneumatic telegraphy . "*Scientific American Sup.*," 75.
Pneumatic telegraph . "*Scientific American*," xxxiv. 19.
"*Scientific Amer.*," xxxvi. 175.
Signal, *Chambers* . . . * "*Railroad Gazette*," xxiii. 55.

Pneu-mat'ic Tube Dis-patch'. See the history and details, pp. 1755–1757, "*Mech. Dict.*"

The tubes of the Western Union Telegraph Co., New York, are 2½″ interior diameter, with a capacity for sending 4 boxes a minute. The pipes, which are 18′ long, and joined by air-tight screw-joints, are laid 3′ under ground. The curves have a radius of 12′. The engine in use is a 30 horse-power compressing engine; and exhausting at the same time from two separate reservoirs. It has a capacity for 40 tubes.

The pneumatic dispatch service, of Berlin, Germany, embraces 26 kilometers of tube, and has 15 initial stations. The wrought iron tubes have a clear breadth of 65 millimeters, and lie about one meter below the surface of the ground. The letters and cards which are to be forwarded have a prescribed size, and are inclosed in iron boxes, or cartridges, each of which can hold 20 letters or cards. In order that they may pack closely, they are covered with leather. From 10 to 15 cartridges are packed and forwarded at a time; behind the last cartridge is placed a box with a leather ruffle, in order to secure the best possible closure of the tube. At four of the stations are the machines and apparatus needed for the business. The forwarding of the boxes is effected either through compressed or rarefied air, or through a combination of the two. Steam engines of about 12 horse-power are used for the condensation or exhaustion of the air. Each main station has two engines, which drive a compressing and an exhausting apparatus, the steam for each engine being furnished by two boilers. Large reservoirs are employed, both for the condensed and for the rarefied air. The former has a tension of about three atmospheres; the latter of about 35 millimeters of mercury. The air, which is heated to 45° C. by the compression, is cooled again in double-walled cylinders which are surrounded by water. The velocity of the boxes averages 1,000 meters per minute, and a train is dispatched every 15 minutes. Each of the two circuits is traversed in 20 minutes, including stoppages.

The service between Paris and the chambers where the sittings of the National Assembly were held at the Palais in Versailles, involved a line of 11 miles, and the packages were dispatched at an average of 8 minutes for the course. The tubes were 4″ in diameter, and required three steam engines of an aggregate of 50 horse power. An apparatus called a relay acts as an accumulator, and comes in aid of the original impulse at points along the route. The air is forced in at one end and exhausted at the other, the messages are in boxes forming a train, and the relays come into action immediately that a train passes a station.

The French method of locating the position of an obstruction in a pneumatic tube is by firing a pistol into the tube. The resulting wave of compressed air, traversing the tube at the rate of 1,000′ a second, strikes the obstruction, and is then reflected back to its origin, where it strikes against a delicate diaphragm, and its arrival is recorded electrically upon a very sensitive chronograph, on which also the instant of firing the pistol had been duly recorded.

Berlin . . . . . "*Telegraphic Journal*," iv. 246.
* "*Scientific Amer.*," xxxviii. 18.
"*Scientific American Sup.*," 376.
"*Min. & Sc. Press*," xxxvi. 51.
New York . . . . . * "*Scientific American*," xxxii. 223.
"*Scientific American*," xxxv. 328.
London . . . . . * "*Scientific American Sup.*," 31.
Postal, Vienna . . . . * "*Scientific American Sup.*," 1426.
Western Union . . . "*Telegraphic Journal*," iv. 161.
System, *Culley* . . . "*Van Nostrand's Mag.*," xiv. 111.

Pneu'mo-graph. The *cardiograph* of M. Marey is capable of being used also as a *pneumograph* by an adaptation of the apparatus of exploration.

This consists of a spiral spring inclosed in rubber and forming a hollow extensible cylinder of which the ends are closed. A lateral tube places the interior of the cylinder in communication with the registering apparatus, which is shown under CARDIAGRAPH. Each action of inspiration and expiration produces a movement of contraction or extension of the cylinder, which reacts upon the registering lever.

The elastic cylinder is placed with its end on the breast of the subject, and is included within an inelastic band which encircles the chest. As the chest expands and contracts in the act of breathing, the cylinder is condensed and dilated respectively, the air passing by the tube to the registering apparatus.

Laboulaye's "Dictionnaire," cap. "Graphiques."

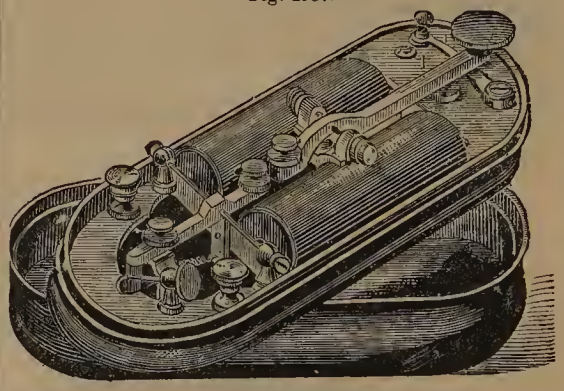
Pock'et. (*Mining.*) A rich spot in a vein or deposit.

Pock'et Mi'cro-scope. (*Optics.*) A portable microscope, to be carried in the pocket for field purposes; sometimes a set of single lenses; sometimes supplied with a compound body.

Pock'et Net. (*Fishing.*) One with a relatively small compartment in which the fish are collected. See TRAP NET. See also TRAMMEL NET.

Pock'et Re'lay. An instrument for making telegraphic connection at any point on a line, to communicate in case of accidents, etc. Also known, from its use, as a *wrecking instrument.*

Fig. 1987.



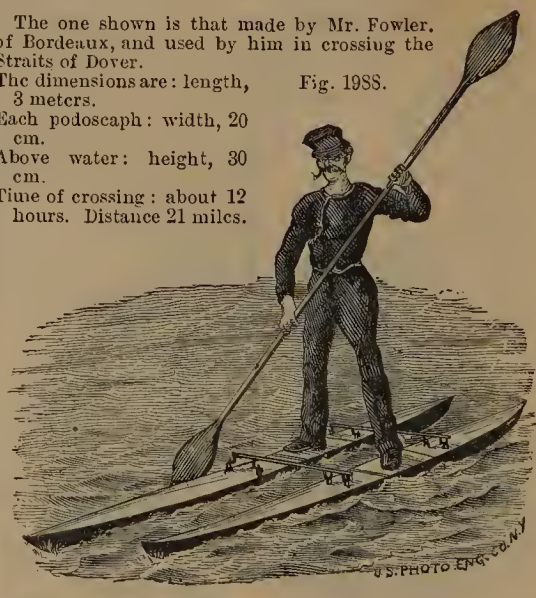
Pocket Relay.

Po-dom'e-ter. See PEDOMETER.

Po'do-scaph. A foot boat; one in which canoe-shaped floats are attached to or support the feet.

The one shown is that made by Mr. Fowler, of Bordeaux, and used by him in crossing the Straits of Dover.
The dimensions are: length, 3 meters.
Each podoscaph: width, 20 cm.
Above water: height, 30 cm.
Time of crossing: about 12 hours. Distance 21 miles.

Fig. 1988.



Fowler's Podoscaph.

Pog'gen-dorf Bat'te-ry. (*Electricity.*) 1. A Smee battery, in which pulverized copper is deposited upon the copper electrode.

Niaudet, American translation . . . . . p. 59.

2. A modification of the Grove battery, in which

the platinum is in the shape of an S, and is fastened to a porcelain stopper, which nearly closes the porous jar.

Niaudet, American translation . . . . . * p. 155.

Point Find'er. An instrument for finding the vanishing point in making perspective projections.

"*Engineering*" . . . . . * xxii. 223.

Point'ing. 1. (*Milling.*) A preliminary in the preparation of grain for the mill in the modern process; it consists in rubbing off the points of the grain, *clipping* the *brush*, and removing the germ end.

This is done in a machine like a *smut mill* (which see), or by passing the grain between mill-stones separated from each other by a distance a little less than the length of the grain. The grain is only abraded when in a position vertical to the surface of the stones. This is the first operation in the *high-milling* process, *which see.*

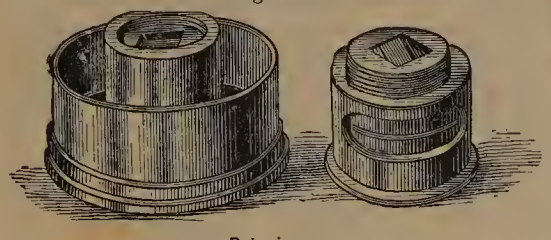
2. (*Metal Working.*) A machine for finishing the ends of nails, pins, or wire.

* "*Iron Age*" . . . . . xxii., December 26, p. 1.

Po-lar'i-scope. (*Optics.*) An instrument for analyzing the light thrown through an object, whereby, in accordance with its varied texture, varied shades of the spectrum are given to its different parts. This is usually effected by two Nichols prisms of Iceland spar; sometimes by means of tourmalines. See TOURMALINE.

One of the prisms is placed beneath the object and above the mirror, and is called the *polarizer*. The other prism is

Fig. 1989.



Polariscope.

above the object-glass, and is called the *analyzer*. By revolving either of these prisms variations in the tints of the spectrum are produced.

The polariscope is an invaluable adjunct to the microscope for detecting the structure of mineralis, animal tissues, vegetables, crystals, etc.

Laurent's polariscope, used in determination of quantity of sugar in solutions, is described in Dr. McMurtrie's report on beet sugar, 1880, "*Dept. Agric. Special Report*," No. 28, pp. 84, 85.

Polar clock . . . "*Scientific American Sup.*," 505.
"*Mech. Dict.*," Figs. 3767–3769, p. 1759.
Lockyer's "*Spectrum Analysis.*"
Schellen's "*Spectrum Analysis.*"

Po'lar-i-za'tion. Broadly, the definition is thus given by a philosopher: —

"When a particle of a body possesses qualities related to a certain line or direction in the body, and when the body, retaining these properties, is turned so that this direction is reversed, then if, as regards other bodies, these properties of the particle are reversed, the particle, in reference to these properties, is said to be polarized, and the properties are said to constitute a particular kind of polarization." — *Clerk-Maxwell.*

1. (*Galvanic Batteries.*) The accumulation of hydrogen upon the negative plate, followed by the deposition of zinc from the said plate, by which the current is weakened.

2. (*Magnets.*) The establishment of magnetic poles in a piece of steel or iron, as of a compass needle or the soft iron core of an electro-magnet by means of a generated circuit.

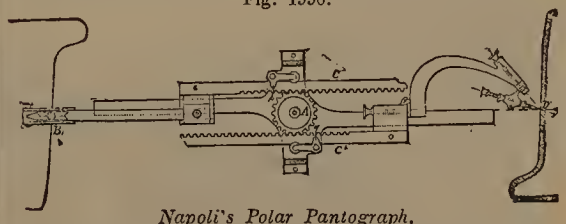
3. (*Light.*) The separation of a pencil of light into two rays, in planes at right angles to each other, known as the ordinary and extraordinary rays, which may be done by double refraction or by reflection.

4. (*Heat.*) A similar action with heat rays.

Po'lar Pan'to-graph. An apparatus devised by M. Napoli for copying on paper the profiles of worn railway-wheel tires.

The apparatus, shown in Fig. 1990, consists of a light frame, having mounted on it the toothed wheel *A*, into which gear the rack bars *C C'*, the former of these being

Fig. 1990.



Napoli's Polar Pantograph.

provided with a pencil-holder, *B*, while the latter is provided with a pointer, *D*. The arrangement of the parts is such that a line joining the center of the pencil at *B*, with the apex of the pointer at *D*, passes through the center of the wheel *A*, and is bisected by that center. The racks *C C'* are kept in gear with the wheel *A* by rollers mounted on bell-cranks, these bell-cranks being provided with springs which tend to force the rollers against the rack bars. The effect of the arrangement is that any movement in the plane of the wheel *A* imparted to the pointer *D* is exactly reproduced by the pencil *B*, and thus if the pointer *D* be moved over the profile of a tire the pencil *B* will draw that profile on a piece of paper placed under it. The whole apparatus is so mounted that it can be readily attached to the tire of which the profile has to be taken, provision being made for supporting the paper under the pencil *B*.

* "*Railroad Gazette*" . . . . . xxiii. 349.
* "*Engineering*" . . . . . xxvi. p. 427, Fig. 3.

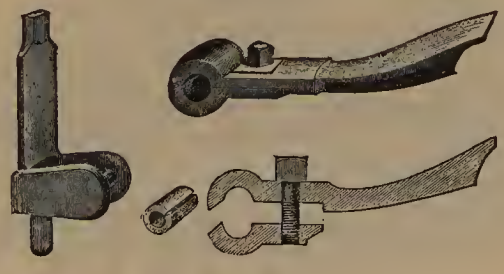
Pole. (*Electricity.*) The wire, plate, or cord leading from the battery. Their names are the opposite of those of the plates from which they lead; thus the zinc is the *positive* metal or plate of the battery, but the wire leading therefrom is the negative pole.

Pole Chan'ger. An instrument for shifting a current from negative to positive, or *vice versa*. See, for instance, the key at Fig. 847, p. 266, *supra*.

Pole Coup'ling. The connection of the pole or tongue with the front axle of a vehicle.

On the left is the clip, not yet bent to clasp the axle. To

Fig. 1991.



Pole and Shaft Coupling.

the right are the shaft-eye and rubber packing, shown complete and in sections detached. The rubber prevents rattling.

Po-lem'o-scope. A reflecting apparatus consisting of a combination of two plane mirrors, so inclined to each other as to enable the spectator, by glancing into one of them, to see the images of objects separated from direct view by intervening obstacles. It is used during sieges to observe the position and movements of the enemy, while the soldiers may remain in shelter behind a parapet.

A simple frame-work of wood supports at the top a plane mirror, with its reflecting surface directed towards the scene to be observed, at an angle of 45°; beneath this mirror is a second one, precisely similar, and with its reflecting surface inclined upward at the same angle as the upper one.

Fig. 1992.

Polemoscope.

The reflecting surfaces of the two mirrors are, therefore, opposite to each other, and parallel. The image received upon the first mirror is reflected directly upon the second, from which it becomes visible to an observer.

See * ALTISCOPE, Fig. 136, p. 69, "*Mech. Dict.*"; INDIRECT POINTING APPARATUS, p. 496, *supra.*

Pole Rail'way. One, the way of which consists of two parallel poles, the cars having tires with concave tread. Used for temporary purposes in the lumber regions in getting logs of a tract to the saw mill. See LOG RAILWAY.

Pol'ish-ing. Materials, tools, and machines are cited and described on p. 1762, "*Mech. Dict.*"

The forms of polishers are: —	Surfaces.	Materials.
Bands.	Bristles.	Borax.
Belts.	Brushes.	Chalk.
Cones.	Buff.	Coleothar.
Cylinders.	Catgut.	Corundum.
Disks.	Cloth.	Crocus.
Drums.	Cotton.	Emery.
Laps.	Felt.	Graphite.
Rings.	Leather.	Oxide of tin.
Sticks.	Metal.	Pumice stone.
Threads.	Stone.	Putty powder.
Wheels.	Thread.	Rotten stone.
	Walrus.	Rouge.
	Wire.	Tripoli
	Wood.	
	Wool.	
	Yarn.	

Pol'ish-ing Disk. (*Dentistry.*) Small instruments carrying a fine powder and revolved by being placed in a drill-stock, to polish the surfaces of dentures, teeth, or fillings. DENTAL ENGINE, Fig. 795, p. 250, *supra.*

Fig. 1993.

Polishing Disks and Points.

Pol'ish-ing I'ron. A small laundry iron, sometimes curved on the face and used in putting the extra finish on shirt fronts, collars, cuffs, etc.

Pol'ish-ing Jack. (*Leather.*) A machine armed with a lignum-vitæ slicker; used for polishing leather when considerable pressure is required.

Pol'ish-ing Ma-chine'. (*Wood.*) A machine having an emery wheel which dresses the face of the work applied thereto.

See SURFACING MACHINE, Fig. 6083, p. 2458, "*Mech. Dict.*"

Speculum . * "*Sc. Amer. Sup.*," 699.
Wheels, *Rose* * "*Sc. Amer. Sup.*," 489.

Pol'y-chrome Print'ing. A process in which colors in blocks are built up together like type in a chase and themselves furnish the color to moistened paper laid thereon. A mosaic of color blocks. — *Johnson*, Br. See also British patent 14,078, 1852, and United States patent, *Laemmel*, July 4, 1871.

Pol'y-con'ic Pro-jec'tion. (*Geodesy.*) A development of the earth's surface in which each parallel of latitude is represented on a plane by the development of a cone having the parallel for its base, and its vertex in the point where a tangent at the parallel intersects a prolongation of the earth's axis.

Pol'y-gon'o-scope. (*Optics.*) An optical instrument for producing and displaying an infinite number of designs and patterns, which can be copied or photographed, and may be used for art manufactures, for amusement, or for other purposes.

The instrument consists of two mirrors fixed in a case and connected together by means of a universal hinge, which is so arranged that the mirrors can be set and fixed at any angle to produce any required design. One of the mirrors is loose in its frame, and can be moved toward or from the other, so that at whatever angle they may be fixed the edges of the mirrors can be made to touch each other, thus preventing the pattern or design from being broken in the center. The apparatus can be closed up in a portable form, similar to an ordinary pocket-book. Patterns having any number of angles or sides may be produced by varying the mirrors. The above has some resemblance to the kaleidoscope. — *Hatton*, Br.

Pol'y-graph. One of the names given to the gelatine copying pad. See GELATINE PROCESS; HECTOGRAPH; COPYGRAPH, *supra.*

In one modification of the process, instead of the gelatine compound in a tray, paper is coated with the material. Sized or unsized paper is coated on one side with a composition consisting of glue, or gelatine, glycerine, soap, and water, approximately in the following proportions, which have been found to give good results in practice: 80 animal glue or gelatine, 20 glycerine, 20 soap, 200 water.

The writing is made in aniline ink.

Then take a sheet of the polygraphic paper, lay it on a damp flannel, sponge with water containing a little alum, lay the writing thereon, ink to the gelatine, back with a sheet of paper, and put the pile in the ordinary copying press. — *Alisoff.*

Pol'y-mi'cro-scope. An adaptation of the principle of the revolving stereoscopic camera to microscopic purposes; the objects mounted on plates attached to a band are successively presented to the instrument.

Prof. Von Lenhossek, Buda-Pesth, * "*Scientific American Supplement*," 2267.

Po-lym'e-ter. An apparatus used for testing the distance between railway rails, and detecting inequalities of elevation.

An improved apparatus by M. Coutourier is mentioned in a paper in "*Bimensuel de la Société d'Encouragement*," 1878, p. 385, and republished in the proceedings of the "*Institute of Civil Engineers*," London.

It consists of an iron triangular ruler 6½" in length, having the long side for its base, furnished with a movable arm

which is pressed against the rail by a spring. The arm communicates with a pointer, which stands at the zero of a finely divided scale when the rails are at their normal width apart ($4' 8\frac{1}{2}'' = 1.447$ meters). Any deviation from this, more or less, is indicated on the scale.

At the side, a pendulum is attached to the ruler, which, when vertical, points to the zero of a circular scale; any change in the inclination of the ruler is communicated to an index sufficiently long to reproduce on the scale the actual amount of the super-elevation — or otherwise — of the rail. This communication can be made either by a toothed wheel or by a series of links from the pendulum to the index. See DYNAGRAPH, *supra*.

Pol'y-phote Reg'u-la'tor. (*Electricity.*) An order of voltaic arc regulators, also known as a *many-light* or *division* regulator, which allows several or many lights on one circuit.

Of this order are several forms, which see —
Differential.
Derivation.
Fixed interval (Regulators *à écart fixé*).

Po-lyp'tome. (*Surgical.*) A hook or écraseur for cutting loose a polypus in uterus, ovary, nasal cavity, etc.

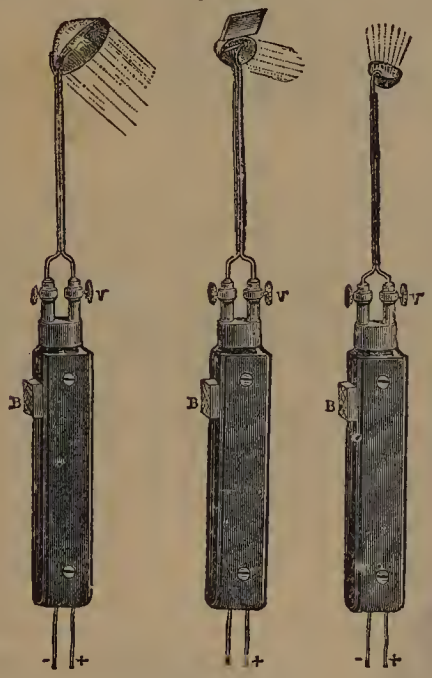
Pol'y-pus For'ceps. (*Surgical.*) For removal of polypi by grasping and wrenching.

Allen's, *Politzer's*, *Bumstead's*, *Avery's*, *Noyes'*, *Hinton's*, *Pomeroy's*, *Tiemann's*, *and Wilde's* ear forceps, pp. 45-47, Part II., *Tiemann's* "*Armamentarium Chirurgicum.*"
Blake's polypus snares, *Ibid.*, p. 45.
Simrock's, *Gross's*, and other nasal polypus forceps, *Ibid.*, p. 57.
Écraseurs and ligators, pedicle forceps and clamps, clamp and sac forceps, tumor forceps, tenacula, vulsellum forceps, etc., for uterine and ovarian tumors, *Ibid.*, Part III., pp. 92-99.

Pol'y-pus In'stru-ments. (*Surgical.*) Prehensile instruments for removing polypi from the nose, ear, uterus, etc.

They are forceps, snares, écraseurs, etc., for grasping, cutting, or tearing loose the sac or tumor, severing the pedicle, etc.

Fig. 1994.



Trouvé's Polyscope.

Pol'y-scope. Invention of M. Trouvé. Designed to illuminate cavities of the human body.

It consists of a secondary Planté battery, with rheostat for regulating the flow of the current, and a galvanometer with two circuits, in which the electro-motive force of the reservoir and that of the Trouvé-Callaud battery, intended to charge it, are opposed.

The instrument has a platinum coil and reflector fitted to a handle, and wire connecting it to the reservoir.

Edison has proposed a small electric light in a glass bolus to be swallowed, in order to illuminate the stomach interiorly.

"*Telegraphic Journal*" . . . . . * vi. 313.
"*Scientific American*" . . . . . * xxxix. 182.

An instrument to illuminate the cavities of the body has also been invented by Dr. Nitze, in Saxony. It consists of a platinum wire kept red hot by an electric current, and inclosed in a glass bulb.

One form is made by Coxeter & Sons, England.

Pol-y-zo'nal Lens. I. A lens having several zones, as in the Dioptric arrangement for lamps and lighthouses.

See circular zones in Fig. 1096, p. 357, *supra*; and cylindrical zones in Fig. 1657, p. 704, "*Mech. Dict.*"
See also * "*Scientific American*, xli. 53.

2. A combination of a number of segmental lenses arranged in zones. Fig. 1376, p. 1763, "*Mech. Dict.*"

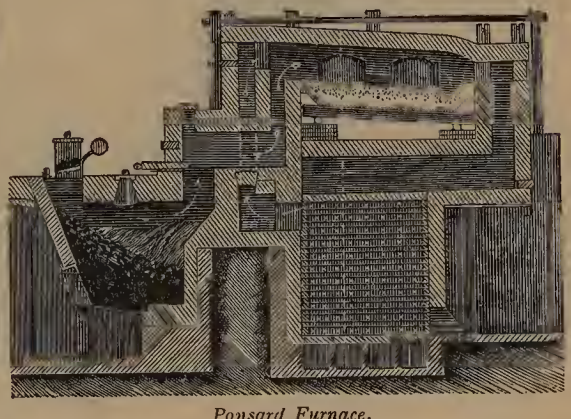
Pon'ci Bat'te-ry. Invention of Prof. Ponci. It consists of a glass jar and porous pot, the former containing a solution of ferric-chloride, in which is immersed a carbon-plate, and the latter containing a solution of ferrous-chloride, in which is immersed an iron plate. Each solution 35° B. "*Telegraphic Journal*," vi. 425.

Pon'sard Fur'nace. An open hearth furnace with a circular inclined and movable hearth, and considered to occupy an intermediate position between the Bessemer and Siemens in the range of its application to the raw materials.

The regenerator, shown beneath, is still more clearly indicated in Figs. 1161, 1162, p. 387, *supra*, where the *Ponsard* regenerator is shown as applied to gas works, and where the distinction between the *Ponsard* and *Siemens* regenerators is pointed out, the latter being shown in Figs. 1159, 1160, on p. 386, *supra*.

The open, circular, inclined and movable hearth of the *Ponsard* furnace is fitted with a pneumatic attachment, so arranged that the tuyeres can be plunged beneath the bath

Fig 1995.

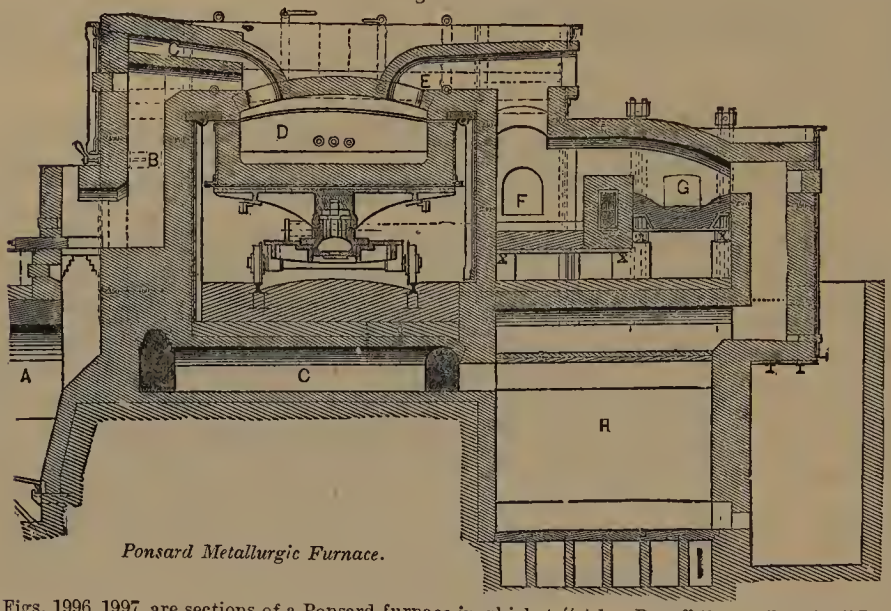


Ponsard Furnace.

of molten metal and the blast turned on, or again brought above it and the blast shut off by a simple half turn of the hearth, allowing the operation to be prolonged or shortened, or repeated at pleasure, without shutting off the heat or retarding the manufacture.

The hearth of the furnace can be readily detached and run out from beneath and away from the heat, affording facilities for repairing or renewing the lining as often as may be required. As the roof will generally outlast five or six hearth linings, the advantage of being able to have a second hearth ready to be run in without letting down the heat is great, particularly in the treatment of highly phosphoric pig by the new methods, in which the basic lining is rapidly destroyed by the reaction.

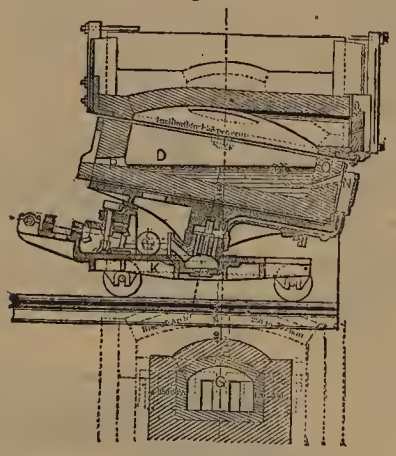
Fig. 1996.



Ponsard Metallurgic Furnace.

Figs. 1996, 1997, are sections of a Ponsard furnace in which the hearth is on a carriage and is run in and out of furnace, and is capable of rotation on its inclined axis. *A* is the producer; *B*, gas flue leading to hearth *D*; *E*, chimney; *R*, regenerator, *C F X*, flues; *G*, heater furnace.

Fig. 1997.



Ponsard Metallurgic Furnace.

Ponsard furnace . . . * "*Engineer*," xlvi. 231.
"*Van Nostrand's Mag.*," xxi. 252.
* "*Iron Age*," xx., July 19, p. 5; xxii., Sept. 16; Oct. 17; Oct. 31; * Dec. 12.
Its work . . . . . "*Iron Age*," xxiv., Sept. 4, p. 3; Sept. 11, p. 15.

See also REGENERATOR FURNACE; GAS GENERATING FURNACE, Figs. 1161, 1162, p. 387, *supra*, and references *passim*.

Pon'ty. The glass-blowers' tube.

M. Clémandot, of France, recommends nickel plating pontils and glass molds, to prevent coloration of the glass by oxidation of the iron. It is adopted in several French factories, the plan being to put the objects in a plating bath of a sulphate of nickel and ammonia for several hours.

Pony Truck. A truck with a single pair of wheels. Shown in Fig. 1998 as in advance of the drivers and just behind the pilot.

In Fig. 168, p. 65 *supra*, it is shown beneath the rear of the locomotive.

Po-poff'ka. A circular ironclad, the invention of Admiral Popoff, of the Russian navy.

The "Novgorod" and "Adm. Popoff," described in "*Iron Age*," vol. xix., June 7, p. 26.

See also references under "*Iron Clad.*"

Por'ce-lain. (*Ceramics.*) A hard, partially vitrified, form of pottery, divided into two classes known as *hard* and *soft*, which names indicate the comparative hardness of the wares, due largely to the different quantities of silica in the composition. The porcelain of China (see p. 1765, "*Mech. Dict.*") is composed of *kaolin* and *petuntze*, one a peculiar clay and the other a feldspar. Silex (flint) is a form of silica commonly used in English porcelain, and entering as it does into some of the better forms of stone-ware and queen's-ware, they partake largely of the porcelain character.

Porcelain is translucent and breaks with a vitreous fracture, bright and clean, differing from the softer forms of pottery of which faïence forms the most attractive example.

Brogniart's classification, under the general head of "*Poteries à Pâte Translucent*," enumerates three kinds of porcelain: —

1. Hard porcelain: *porcelaine dure*.
2. Natural soft porcelain: *porcelaine tendre naturelle*.
3. Artificial soft porcelain: *porcelaine tendre artificielle*.

1. HARD PORCELAIN is distinguished by a fine, hard, translucid paste; it has a hard earthy glaze and a more vitreous character than other pottery, which accounts for its glassy fracture, and its sonority.

The elements which enter into the composition of hard porcelain are kaolin, feldspar, chalk, and sometimes silicious sand, plastic clay, and powder of broken porcelain.

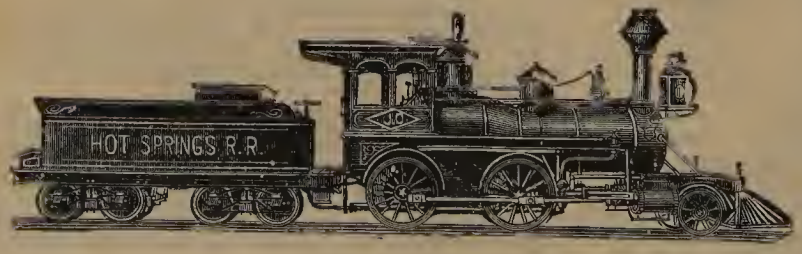
Following in the description the practice at the manufactory at Sèvres: —

The kaolin of St. Yrieix yields both the argillaceous, flinty varieties. The feldspar is taken from a rock of pegmatite at St. Yrieix. The silicious sand is from Aumont, near Creil. The chalk is from Bougival. The plastic clay from Abondant, near the forest of Dreux.

The following is the composition at Sèvres: —

Silex	0.580
Alumina	0.345
Chalk	0.045
Potash	0.030
	1.000

Fig. 1998.



Pony Truck Locomotive.

The preparation of the paste is by means of careful grinding, levigation, sifting, incorporation, dilution, straining, ripening, and the subsequent operations upon the paste are by means of throwing or molding, or the two united much as in other species of pottery but with greater exactness and delicacy in proportion as the work is of a more delicate or elaborate description.

Owiug, however, to the less plastic and tough character of the porcelain paste great care is necessary, and processes for condensing the pa te by pressurc in bags or wire cloth vessels have been employed, and are described by Broguiart and others as the invention of MM. Honoré, Grouvelle, Alluand, de Caen and others. See under "*Poterie*," Laboulaye, vol. iii.

The paste for articles of statuary which are not to be glazed but remain in biscuit form is composed of: —

Clay of the flinty kaolin	0.64
Feldspar	0.16
Sand of Aumont	0.16
Chalk	0.04
	1.00

The largest pieces are made of a much more plastic composition hy M. Regnier: —

Clay of flinty kaolin	0 43 to 0.44
Pipe clay of Ahondant	0.21 to 0.25
Feldspar	0.16 to 0.17
Quartzose sand of Aumont	0.16 to 0.09
Chalk	0.04 to 0.05
	1.00 1.00

The mode of fashioning is by throwing-wheel or mold, which see.

After a slight drying in the air, the pieces are baked in the waste-heat chamber at the upper part of the porcelain kiln, (see PORCELAIN KILN), where they are carefully preserved from soot hy encasing in *casettes*, which are boxes of refractory clay like seggars, which see.

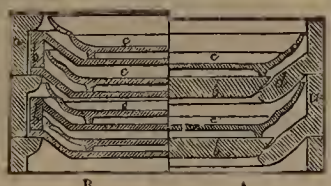
The glaze (Fr *couverte*), is of the pegmatite of Saint Yrieix, the mean composition of which is: —

Silex	0.74
Alumina	0 18
Potash	0.07
Chalk and manganese	0.01
	1.00

The articles are dipped in the slip, which is the result of the most careful grinding and straining, and the quality is judged hy the rate at which it will descend in still water in a cylindrical graduated glass vessel, iu which it has been agitated so as to be in a state of suspension.

The firing of the ware is done at a high temperature so as to soften the compound, which is partially fused by the heat, giviug it the vitreous and translucent character which helongs to porcelain. See PORCELAIN KILN.

Fig. 1999.



Seggars for Sèvres Porcelain.

The encasing of the pieces in the kiln is a carefully arranged matter, and the accompanying figure shows two forms, oue half of each heing represented. In each case the rings *a* have spurs projecting inwardly on which are laid rondeaux, *b*, which serve to support the plates or dishes *c c*. The seggars (*casettes*) are of a special size aud height for each descriptiou of ware. See PORCELAIN KILN.

2. NATURAL SOFT PORCELAIN. This is an English invention of which the Worcester porcelaiu may be cousidered the representative. The works at that city were started about 1751. The paste is a grade between fine faïence and hard porcelain. It is distinguished hy having a base of kaolin and a large proportion of phosphate of lime obtained by the calcination of bones.

The following recipes show that great latitude of proportiou is practiced: —

	Saint-Amans.		Aikin.
Argillaceous kaolin, washed	0.11	0.41	0 310
Fliuty kaolin, crude and ground	–	–	0.260
Pipe-clay	0.19	–	–
Calcined flint	0.21	0.16	0.025
Phosphate of lime	0.49	0.43	0.405
	1.00	1.00	1.000

The paste is very plastic and is fashioned after the manner usual with fine faïence, yielding readily to the throwing-wheel or mold The kiln is the same as that used for fine faïencc (see FAÏENCE) having fires *à alandier*. The glaze is lead aud boracic acid glass, harder than that for faïence, but not so hard as the *couverte* of hard porcelain. It is laid on by immersion in the slip glaze.

The following is one example of glaze: —

	Saint-Amans.
Feldspar	0.48
Silex or quartzose sand	0.09
Borax, crude	0.22
Flint glass	0.21
	1.00

The glazing materials are fritted, and after grinding 10 to 12 per cent. of minium is added.

The firing of the glazed and decorated ware is at a moderate heat.

3. ARTIFICIAL TENDER PORCELAIN. — The porcelain made at Sèvres until 1804, wheu the difficulty of working in so little plastic a material caused it to be discarded.

The paste is marly, fine, dense, almost vitreous, hard, translucid, and fusihle at a high temperature. The paste has but little adherence, and was always molded. After having acquired some little teuacity by the addition of a certain quantity of gum adragante, the dry pieces were fiuished on the lathe. The setting of the ware in the kiln or muffle was accompanied with great difficulty, as the objects required to be stayed and supported by pieces made in the same paste in order that they might exactly follow the contraction.

The composition was eminently vitreous. A frit was made as follows: —

Niter	0.220
Grey marine salt	0.072
Alum	0 036
Soda of Alicante	0.036
Gypsum of Montmatre	0.036
Sand of Fontainbleau	0.600
	1.000

The composition of the paste was: —

The frit, as abovo	0.75
Chalk	0.17
Calcarean marl of Argenteuil	0.08
	1.00

The glaze was put on hy sprinkliug. It was composed: —

Sand of Fontainbleau, calcined	0.27
Calcined flint	0.11
Litharge	0.38
Carbonate of soda	0.09
Carbonate of potash	0.15
	1.00

The materials are mixed, melted in a crucible, crushed, and again melted and crushed. The firing is at a lower temperature than that required for the biscuit. Care is taken to treat the interior surface of the seggars (*cazettes*) with the same glaze in order that they may not absorb that of the objects contained in them.

History and development of the ceramic art, report of *Hector Tyndale*, "*Centennial Exhibition Reports*," Group II., vol. iii., p. 2.

Chemistry and composition of Japanese porcelains and porcelaiu rocks, by *Wurtz*, *Ibid.*, 114.

Prof. Wurtz, report on

Japanese . . . . "*Eng. & Min. Jour.*," xxiii. 199.
Paintiug, *Joclet* . . . "*Scientific American Sup.*," 2895.
* "*Man. & Builder*," viii. 132.
"*Scientific American Sup.*," 2706.

Brogniart's "*Arts Céramiques.*"
Marryatt's "*History of Pottery and Porcelain.*"
Birch's "*History of Ancient Pottery.*"

Por'ce-lain Ce-ment'. For mending china or glass ware.

Gelatine	5
Chromate of lime	1

Anoint the edges, press together, and expose in the sunlight.

Por'ce-lain Col'ors. (*Ceramics.*) Colored glasses which fuse upon the biscuit surface in firing. Fluxes with metallic colors; oxides generally.

Cobalt	Blue.
Chromium	Green.
Oxide of iron	Brown.
Oxide of urauium	Black.
Oxide of titanium	Yellow.
Chromate of lead	Yellow.
Chromate of haryta	Yellow.
Oxide of manganese	Black, violet, brown.
Sesqui-oxide of iridium	Black.
Oxide of cohalt	Black, blue-grey.
Proto-chromate of iron	Brown.
Purple of cassius	Purple.
Sub-oxide of copper	Red.
Oxide of copper	Green.
Oxide of chromium	Green.

Por'ce-lain E-lec'tro-pla-ting. Sulphur is dissolved in oil of lavender spike to a sirupy con-

sistence; then chloride of gold or chloride of platinum is dissolved in sulphuric ether, and the two solutions mixed under a gentle heat. The compound is next evaporated until of the thickness of ordinary paint, in which condition it is applied with a brush to such portions of the china, glass, or other fabric as it is desired to cover, according to the design or pattern, with the electro-metallic deposit. The objects are baked in the usual way before they are immersed in the bath.

Por'ce-lain Kiln. The porcelain kiln is a high cylindrical tower with a dome, built of refractory bricks. It has two or three vaulted stages and is flanked at its base by several furnaces, from which the flame reaches the lower kiln chamber by horizontal passages, thence the upper chamber by vertical canals, and eventually the chimney at the summit.

See Plate XXXV. which is a representation of the porcelain kiln of Sèvres, France.

The upper chamber is for the baking of the green ware, bringing it to the biscuit stage, after which the objects receive the glaze (*couverte*) and then take their final firing in the lower story. The pieces are placed in refractory clay boxes termed (*cazettes*) seggars (which see), which are piled in the furnace forming high columns which reach almost to the vaulted ceiling. The door of the kiln (*laboratoire*) is then closed and luted, and the fires lighted in the furnace. The fires burn about 36 hours.

The chambers of the kiln are entered by arched openings which are bricked up when full and the kiln is ready to fire. The furnaces are 6 in number, around the base of the kiln, and the fire is direct, the air to support combustion entering by way of the ash-pot as usual.

The *couleurs de grand feu* are required to support an equal temperature with the paste but they are not so numerous as the other class of colors, *couleurs des moufles*, which are fired in muffles divided into stories and celles. See PORCELAIN MUFFLE.

Another form of porcelain kiln at Sèvres has furnaces *à alandier*, with a diving draft. Fig. 36, p. 20, *supra*, shows a three-story kiln with furnaces around them, but the section cuts through only one at each stage. The two lower ones are *a alandier*.

Por'ce-lain Mold'ing. (*Ceramics.*) In molding porcelain, if the hollow object is to have two exterior faces, the mold is in two parts, which, when joined, present an interior surface corresponding to the relief of the object; the paste is applied in each portion and smoothed on the exposed surface, which forms the interior of the vase (for instance). The parts of the mold are then brought together and the joint made by the hand, a spatula, or a smooth shell introduced into the interior.

A hollow shallow object such as a dish or tureen, is made by another method, termed *moulage à la croute*, the paste is rolled upon a marble table, in the manner of a pie crust, hence the name, and is laid upon the mold, applying to the surface a sponge dipped in thin slip. See Plate XXXVI.

For thin hollow objects, the *moulage par coulage* is adopted, the thin paste being poured into the mold, which has a plug at the bottom, which is opened after a time to allow the superfluous slip to run out; the mold is porous, and the plug is withdrawn after a time determined by experience, when a sufficient thickness of the slip shall have adhered to the mold. The operation may be repeated for a greater thickness.

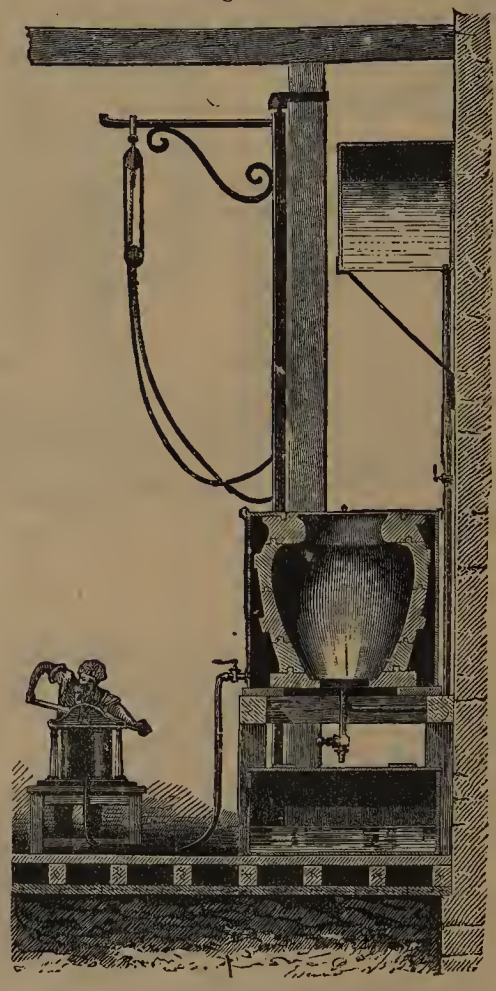
For a cup it needs but to pour a thin slip into a cavity of the right shape in a block of plaster. The water passing through the pores of the plaster allows the paste to gather on the sides of the mold, and the superfluous paste is poured out. This is the way in which very thin ware is made.

In making thin objects of large size by *coulage*, the aid of an air-pump is called for: either to compress the air inside the mold, or to remove the natural pressure of the air from the exterior of the hollow mold. See Plate XXXVI.

In the former case (compression) the slip is projected into the interior of the hermetically closed mold by a tube of caoutchouc, and the superfluous slip withdrawn by a faucet below; the compressed air introduced into the mold by another tube holds against the interior of the mold the paste which would be disposed to slip down.

In the latter case (exhaustion), the upper part of the mold is open to give access to the atmosphere and all the remainder of the mold is covered by a box of sheet-iron, as in Fig. 2000. The slip is injected and the excess drawn off by the

Fig. 2000.



Regnault's Apparatus for Molding with Air Exhaust (Section).

faucet below. The air inside the box around the porous mold is withdrawn by means of the air-pump, and the atmospheric pressure upon the paste adhering to the mold keeps the paste from slipping down, as mentioned in the previous case.

The molding completed, by means stated, the object is allowed to dry in position, by absorption of its moisture by the mold and the action of the air; the shrinkage renders it easily withdrawn and it is then finished. This may be upon the wheel, by scraping, by adding to or mending portions, hollowing out, stamping, adding molded portions, carving, and ornamenting in various ways with colors, designs, and what not.

To resume at the point of withdrawing the green ware from the mold, — the objects are dried in the air for several days, and then those which were fashioned upon the wheel are returned to it, and by means of sharp tools, of shapes and sizes, called *tournassins*, which have some resemblance to metal-turning tools, — the object is retouched, the angles sharpened, hollows deepened, the protuberances and moldings smoothed, the foliation repaired, and the whole object brought to the detail and thickness required. This operation is the *tournassage*.

Scraping (*grattage*) is adopted with objects not fashioned on the wheel.

The repairing or refilling (*remplissage*) which follows, consists in stopping up with paste defects in the molding, or holes produced in the subsequent *tournassage*.

The *evidage*, *estampage*, and *moletage* which follow, refer to the engraving, recessing, stamping, molding, and attaching molded ornaments, after which come the artistic sculpturing and the *garnissage*, which last refers to the surface artistic ornamentation. The next operation is firing. See PORCELAIN KILN.

Certain kinds of articles required in large numbers and of exactly equal size are molded by revolving wheel and templet, as in Fig. 7201, p. 2770, "*Mech. Dict.*"

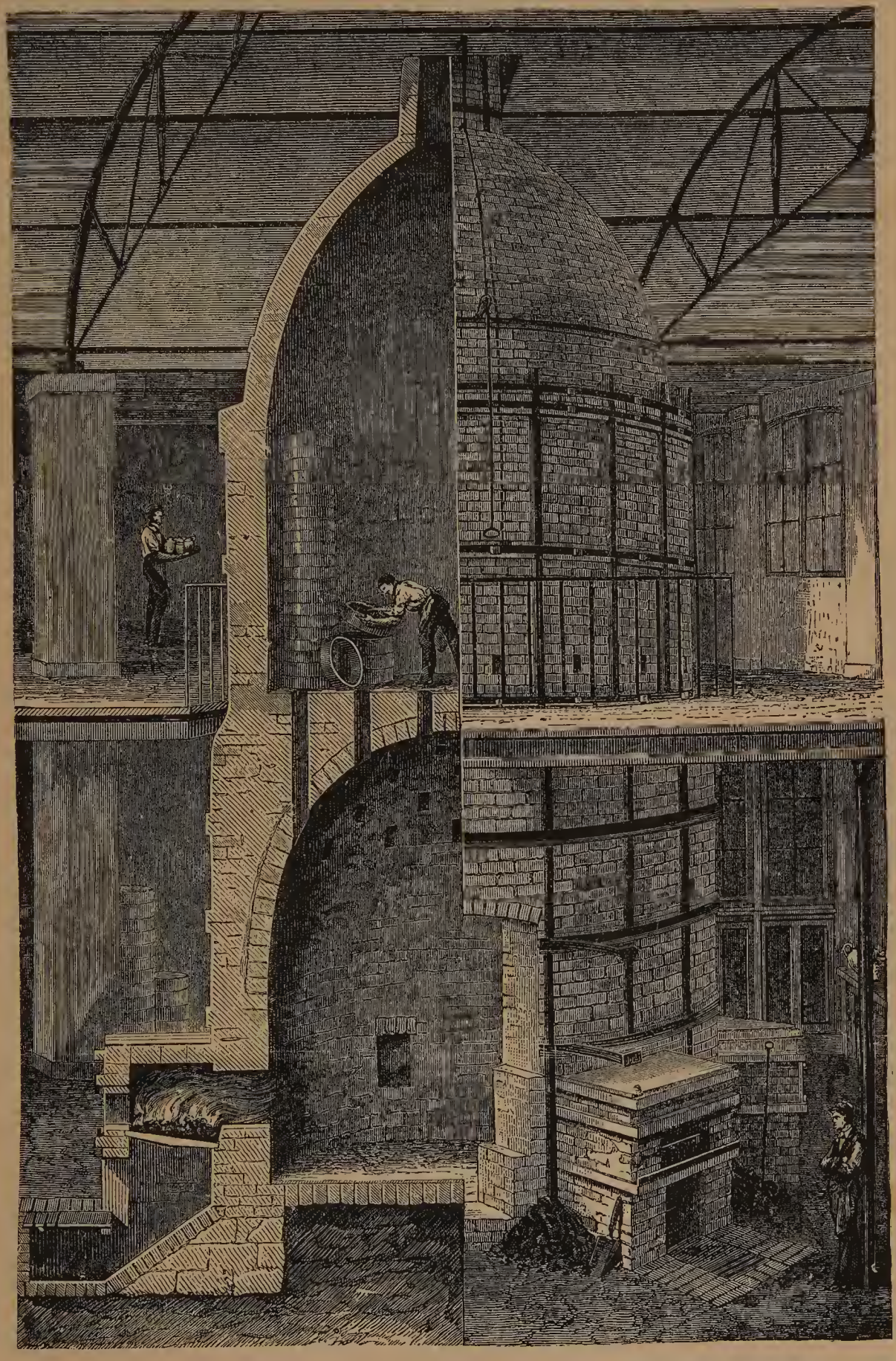
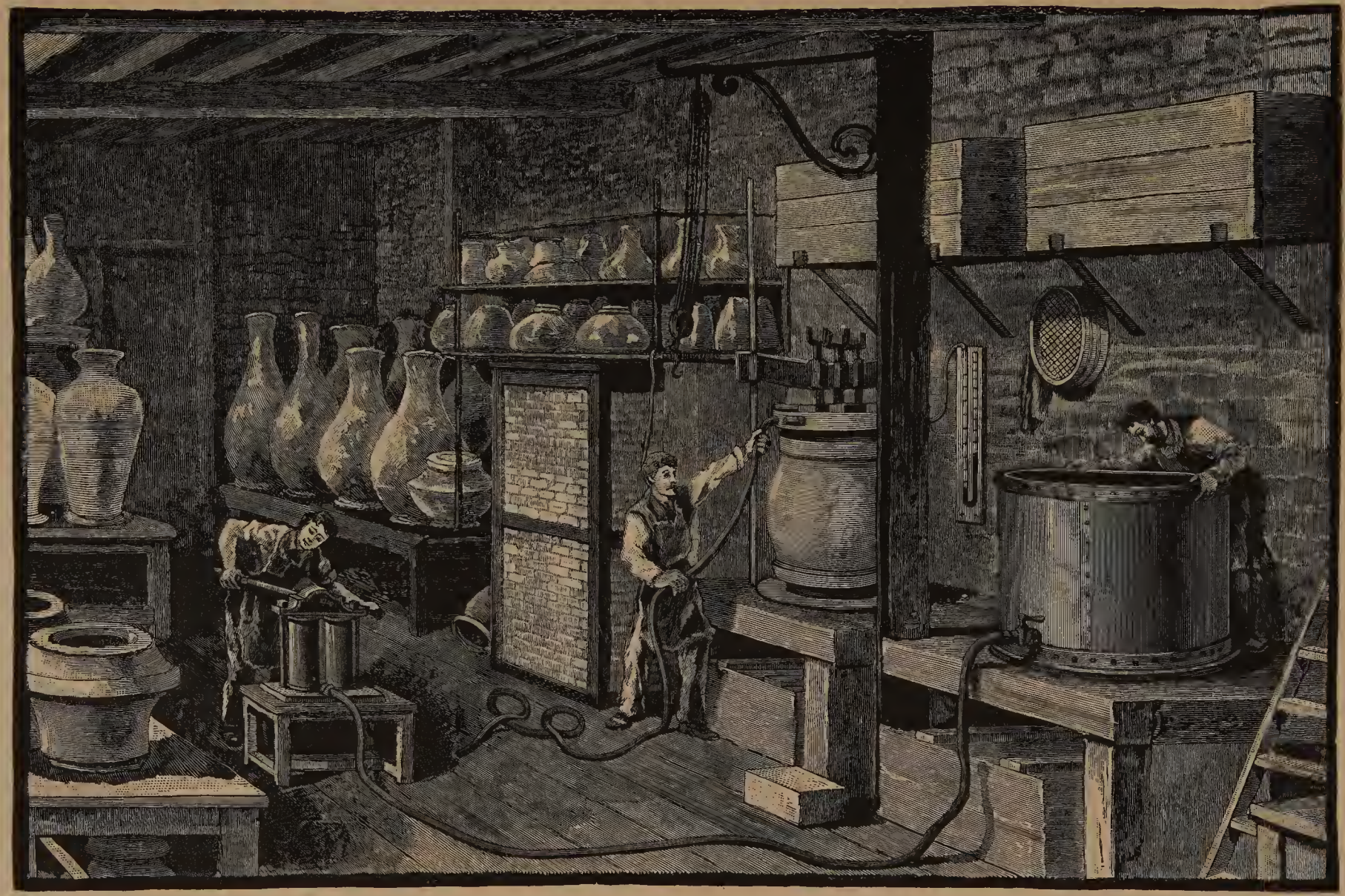


PLATE XXXV. PORCELAIN KILN, SÉVRES. (*Section and Elevation.*) *See page 704.*



MOLDING ROOM, SÈVRES.

WITH AIR COMPRESSION AND EXHAUSTION APPARATUS.

See page 704.

The templet, having at its working edge the exact half figure of one face of the object, is attached to a plate which is adjustable on an arm which has a center of motion to permit adjustment.

The plate is adjustable vertically and longitudinally on the arm, and a plate beneath the arm, secured by set screws, limits the downward drop of the arm, the latter is held down at the required distance by a set nut. By means of all these adjustments the required thickness is given to the plate, saucer, or other object, the top of the turning wheel giving the conformation to the interior surface of the article. The distance between the templet and wheel is the thickness of the article. Templets, for each different article required to be fashioned, are kept in stock, and are placed at pleasure on the arm; a suitable wheel-head also being attached to the vertical spindle to correspond with said templet.

Por'ce-lain Muf'fle. A kiln in which porcelain is fired to fix the colors which will not bear the great heat of the porcelain kiln. The colors are divided on this line into *couleurs de grand feu* and *couleurs des moufles.*

The muffle is a box of refractory clay, divided into stories and cells to contain painted porcelain, and is enveloped in the flames of the furnace, which, however, do not reach the interior, as the effect of contact of flame and smoke would

Fig. 2001.

Muffle for Firing Decorated Porcelain. (*Sèvres.*)

deface the objects. The inclosed ware is examined by means of peep-holes (*visières*), which are closed by a removable plug of baked clay. The condition of the ware is ascertained by the color and by the effect of the heat on slips which can be withdrawn for accurate examination.

Por'ce-lain Pâte Ten'dre. (*Ceramics.*) Soft paste porcelain. *Vieux Sèvres:* made there till 1804.

Por'ce-lain Plate Ma-chine'. The machines shown in Figs. 2002, 2003, 2004, are those used in the making of porcelain plates by M. Faure, of Limoges, France.

The hand process may be first described in brief:

"To produce the plate, three distinct operations are necessary — the forming, the molding, and the turning. The forming (*ébauchage*) consists in giving to the soft paste an approximate form. The workman taking a ball of the plastic mass places it on a wooden disk, the center of which coincides with that of his wheel. He then flattens the mass until it assumes a lenticular shape, the molecules being pressed to follow a spiral from the center outward. This is then put in a dry place for a short period. Molding consists in forcing the mass formed as above into a mold, which imparts to it the exterior form of the plate. By means of a dampened sponge the workman presses on the paste until it takes the imprint, working always from center outward, and leaving enough material wherewith to form the base portion. With a knife he removes the excess of material and then places the plate in a drying chamber, where it becomes sufficiently solid to be removed from the mold. It is then about twice the thickness to which it ultimately must be reduced.

"The turning operation brings the object to its proper dimensions. A cutting tool is used to remove the excess, and

Fig. 2002.

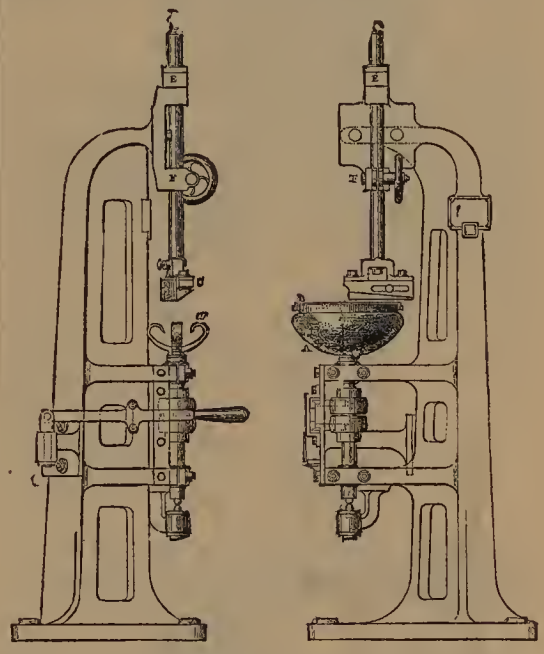


Plate-making Machine. Limoges (*Croûte Making.*)

the diameter of the plate being traced with a compass, it is removed and finished by thinning the edges. The plate is then ready for baking.

"The difficulty in the above is that peculiar to all handwork — variability.

Fig. 2003.

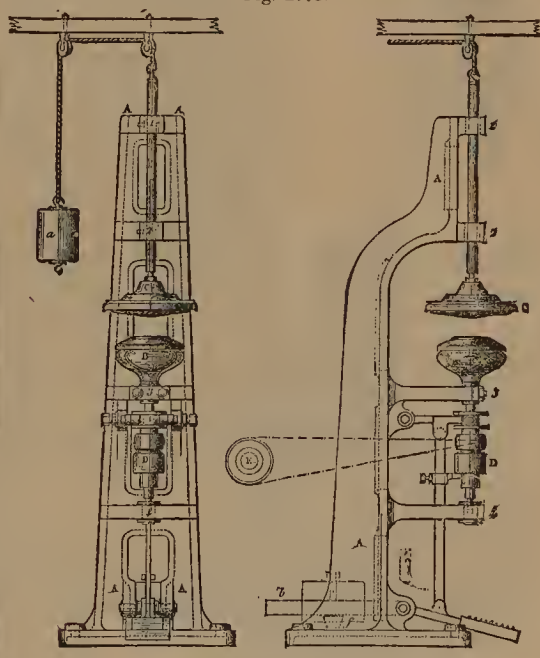


Plate-making Machine. (*Molding.*)

"Fig. 2002 exhibits side and frout views of the apparatus for making *croûtes*, or thin flat disks of paste. *A* is the lathe head made of plaster mortar, formed on the iron armature *a*. *B* is a piece of sheepskin exteuded on a copper circle. *C* is the calibrating tool which spreads the paste. *D* is the tool arbor. This is lifted by a cord and pedal, and descends by its own weight. *E* is a stop limiting the descent, which is also adjusted by the device at *F*. The plastic material is placed in ball-shape on *B*, and the lathe set in motiou by pressing a pedal. A second pedal-pressed tool descends vertically, with an accelerated velocity at the beginning, stops a few seconds for the operator to eenter the ball with the palm of the haud and hold it so as to resist the eentrifugal force, and theu continues its travel with slaekened speed. At the end of its movement the tool has reduced the paste into a eake, of a surface and volume eonforming to that which the plate ultimately is to possess. As soon as one *croûte* is prepared the tool rises, and a second ball of paste is inserted, and so on.

"The secoud apparatus, as shown in the front and side views in Fig. 2003, serves to replaee the *croûte* in the axis of the lathe without deviatiou of the eenter, when turned over to be brought in contact with the mold. *A* is a east-iron frame carrying four collars, 1, 2, 3, 4, the axes of whieh coincide. The puir above guide the tool arbor; those below, the lathe spindle. *B* is the lathe head surmounted by the mold. *C* is a platform to whieh is secured the sheepskin cirele to which the *croûte* is attaehed. By carrying this platform dowu, the *croûte* is brought in eontact with the mold. When the *croûte* is detaehed the platform and sheepskin is lifted by the counter weight *a*. *D* is a friction gear thrown into action by the counterweighted pedal *b*. This serves to throw the lathe into or out of motion at will. *E* is the motor.

"The third apparatus, of whieh a front view is given in Fig. 2004, eonsists of a vertical frame carrying the lathe below, a calibrating tool in the eenter, and the molding tool above. The *croûte A* coming from the second machine is secured to the lathe head. *B* is the molding tool moved by the handle *C*. *D* is an adjustable eollar. *E* a carriage regulating the movement of the tool effected by the handle *F*. *G* is a gage for regulating the form of the plate. *H* is the calibrating tool The *croûte* being on the lathe head the tool is caused to deseend, and this meets the paste at the eenter, determining its thiekness. Being restrieted in its motion by the guide or gage *G* whieh represents the profile of the plate, and being submitted to a horizontal movement, it necessarily works the object aecording to the desired exterior form indicated by the gage.

Fig. 2004.

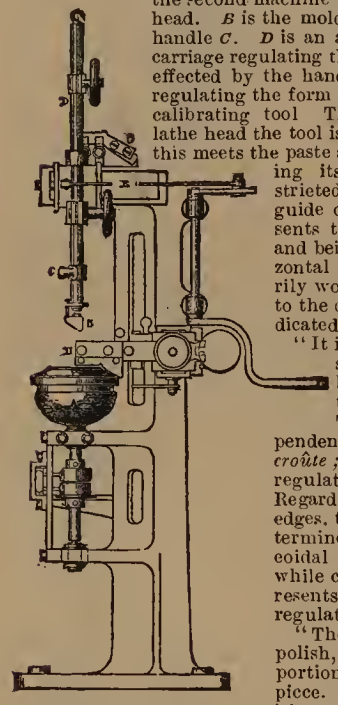


Plate-making Machine.
(Turning.)

"It is evident that the tool should exereise, on the bottom aud rim, eertain relative pressures. These are, however, dependent on the seetion of the *croûte;* and this is perfeetly regulated by the first machine. Regarding the shaping of the edges, the tool aeting at a determined angle and with helieoidal faces euts the paste while compressing it, and represents the work of the hand regulated and perfected.

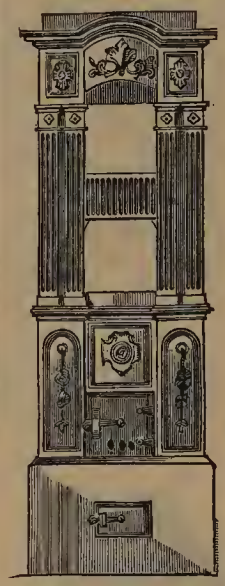
"The calibrating gives the polish, and produees the raised portions which deeorate the piece. The tool merely polishes without pressing, and this terminated, a speeial tool removes the material which extends over the edges of the mold. The workman then lightly lifts the extreme edge so as to faeilitate withdrawal, and removes the mold to a warm plaee for drying, as already explained.

"With regard to production, by hand work alone about 100 plates per day can be made. A single workman, aided by two children, ean by the above maehine average 450 per day." — "*Bulletin de la Soeiété d'Encouragement pour l'Industrie Nationale.*"

Por'ce-lain Stove. The use of porcelain for stoves is very common iu Germany, Austria, and Swedeu. A number of such were shown in Paris, 1878. Figs. 2005, 2006, show two made by Joseph de Ceute, of Vienna.

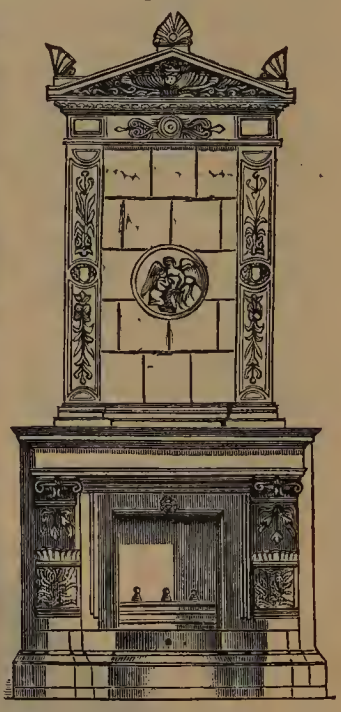
They are the artistie development of the Tartar *kang* and the Russian brick stove, each of which, however, is bedstead as well as stove. The former is heated by fermenting dung, and is a true hot-bed, while the Russian, one step, and a large one, in advance, is heated by burning wood.

Fig. 2005.



Porcelain Stove.
(De Ceute, Vienna.)

Fig. 2006.



German Porcelain Stove.
(De Ceute, Vienna.)

The advantages of the ceramic over the metallic material are several.

1. Not being good conductors of heat, they radiate it slowly and without sudden ehanges.

2. Being bulky, they hold heat equally and for a long time, even after the fire has burned out.

3. They do not seorch or "burn the air," or the floating partieles of dust in it.

4. They have many of the advantages of the open grate.

"The material is earthenware molded into tiles or hollow bricks, about 6″ or 8″ square and several inches thiek. They are made in a great variety of ornamental forms, and are generally glazed on the outer or exposed faee, either white — which is most eommon — or brown, red, green, or blaek. Besides the ordinary flat-faced tiles, they are made with ineised or raised designs, or are molded in high relief, so that when combined they form reeessed panels or projeeting fillets and moldings, in a variety of architeetural patterns.

"The baek portion of the tile exposed to the fire or heated gases rising from it is perforated and peeuliarly shaped, so as to expose a large surfaee and make a series of tubular openings favorable to the absorption of the heat into the body of the tile.

"The shape of the stove formed of these tiles varies with the taste of the fabrieant and the demands of the consumer. They are generally from 6 to 8 or 10 feet high, with a breadth of 3 or 4 feet. Usually there is a deep reeess above the fire-space, or an opening quite through, the stove being divided in that portion into the parts united above by an entablature and eornice. Cylindrieal or eolumnar stoves are also made; indeed, the modifieations are numerous, to conform to the varying taste or fashion of the time. Lower and broader stoves are now eoming into use with large openings in front, so that the fire may be seen and enjoyed as in an open fire-plaee, while the heat is much better utilized." — Prof. Blake.

Po'ro-type. A method of copying engravings. It depends upon the fact that the portion of the face of the print occupied by ink is non-porous.

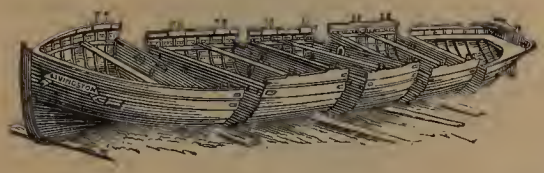
A gas whieh aets upon a certain chemical agent, and either bleaches or discolors it, is permitted to penetrate a copper-plate engraving or woodcut where possible, and, coming into contact, as it permeates, with paper which has been suitably prepared, brings about a reaction, — that is to say, wherever the gas has found means to penetrate, the color of the prepared paper alters, and a copy of the engraving is iu this way produced. — "*Photographisches Archiv.*"

Po'rous Cup. An unglazed biscuit ware, used in batteries to prevent the mixing of two liquids, and yet not oppose the passage of the electric current.

Por'ta-ble Boat. One capable of transportation by land; over portages; sometimes sectional.

Fig. 2007 shows the sectional boat of the African traveler, H. M. Stanley, which he transported overland for the navigation of any rivers and lakes encountered during his researches.

Fig. 2007.

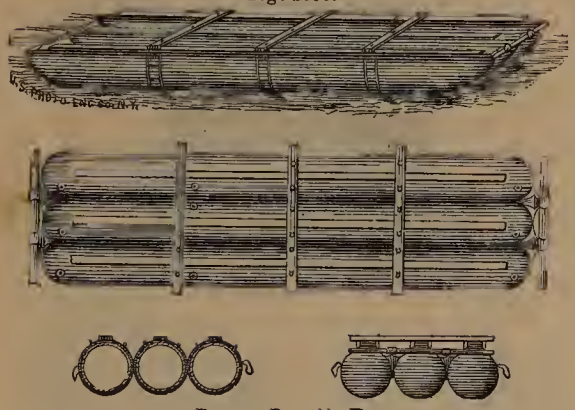


Stanley's Portable Boat.

The boat is, when put together, 40′ long and 6′ 4″ wide. It is composed of 5 water-proof sections, which may be firmly united by means of bolts and clamps. This craft, the "Livingstone," is the largest that has yet floated in the rivers of interior Africa.

Fig. 2008 is a boat, or rather *raft*, made of a number of inflated pontons bound together and braced with bars.

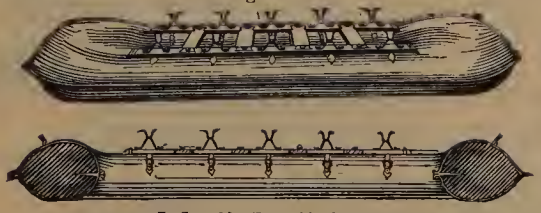
Fig. 2008.



Ponton Portable Boat.

Fig. 2009 is an inflated mattress with gunwale, rowlocks, and thwarts.

Fig. 2009.



Inflatable Portable Boat.

The United States Museum of Fisheries has models of portable and folding boats.

Colvin's. *Hegeman's.*
Fenner's.

Also of canoes, fishing-boats, coracles, etc.

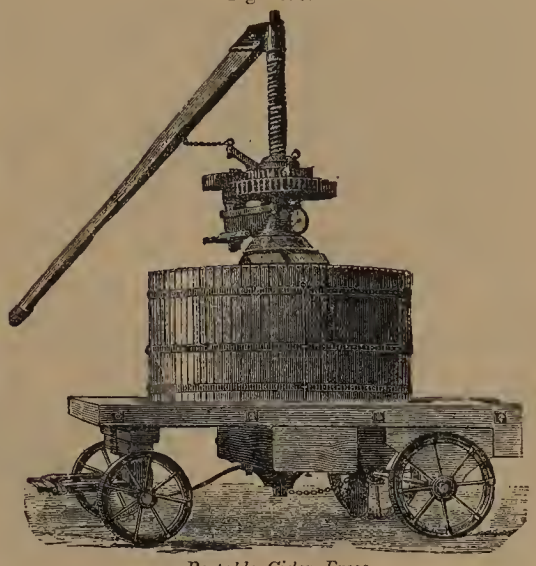
See list of references under BOAT, p. 114, *supra*, to *collapsing*, *folding*, and *sectional* boats.
Also Fig. 2057, p. 899, "*Mech. Dict.*"

Ponton and rigging cutter,
"Grosser Kerfurst" . . * "*Engineer*," xlviii. 375.
Ponton steamer, *Olsen* . . * "*Scientific Amer.*," xliii. 86.
List of boats . . . . . * p. 114, *supra*.
Folding boat . . . . . * Fig. 2057, p. 899, "*Mech. Dict.*"

Port'a-ble Ci'der Press. A press on wheels; much used in Normandy, where the apples are ground and pressed by machines taken from farm to farm, much as threshing is done in this country, and steam-plowing in Britain.

The press shown in Fig. 2010 is one made by Samain, of Blois (*Loir et Cher*). A horse is hitched to the end of the sweep, and the press has three powers of gradually increasing force, being shifted from to each in succession as the pomace becomes more compacted. A dynamometer is attached to indicate the pressure.

Fig. 2010.



Portable Cider Press.

Port'a-ble Crane. One which is transportable upon its base. The traversing crane and overhead crane move on their bases.

See RAILWAY CRANE, *infra*; BALANCE CRANE, Fig. 176, p. 66, *supra*; PORTABLE STEAM-CRANE, *infra*; PORTABLE HAND-CRANE, *Ibid.*

Contractor's hoist, *Chapman & Sutton*, Br. . . * "*Engineering*," xxiv. 304.
Derrick, *Lyons* . . . . * "*Man. & Build.*," xi. 33.
Hoist, *Pennypacker* . . * "*Iron Age*," xix., Feb. 1, p. 1.

Fig. 2011.

Portable Drill.

Port'a-ble Drill. A drill capable of being moved to its work, instead of the converse. See BENCH DRILL, Fig. 287, p. 95, *supra*. Also list under DRILL, pp. 750–752, "*Mech. Dict.*," and references under DRILL, p. 275, *supra*.

The portable drill shown in Fig. 2011 can be placed as easily as a rachet brace, and will drill at any angle in any position, at any distance, and in any direction from the power. The driving apparatus is so arranged that the round belt which drives the machines passes through the center of a hollow stud, enabling the power to be taken off in any direction, while the weighted idler keeps the belt tight at whatever distance the machine is worked.

The machine is intended to be bolted or clamped by its base to the piece being drilled. It can be adjusted in height by drawing the post out of the socket, and radially by screw and handle on the arm. The arm can be swung on the pillar as a center by means of a worm and tangent wheel, thus providing delicate adjustments in every direction. The spindle-frame swings in a ball and socket bearing to any angle up to 30° from the base, and is also provided with means of fixing it in a vertical position. The whole of the machine, including the post, can be drawn out of the socket, and the post passed into the horizontal hole in the socket for drilling in a direction parallel with the base.

The feed motion is self-acting and variable.

See also FLEXIBLE SHAFT, Fig. 1060, p. 347, *supra*.

Thorne, De Haven & Co. * "*Engineer*," xli. 485.
* "*Engineering*," xxii. 110.
* "*Iron Age*," xx., July 19, p. 1.

Port'a-ble En'gine. One upon wheels, either to be hauled from place to place or self-driven. See PORTABLE STEAM ENGINE.

Among the portable engines may be classed —

Agricultural engines.	Traction engines.
Steam fire engines.	Portable steam pump.
Steam road rollers.	Portable steam hoists.
Steam plowing engines.	Portable steam cranes.
Railway crane.	(Which see.)

Port'a-ble En'gine and Pump. The portable engine pump for irrigating purposes is shown in Fig. 2012, as used upon the Nile. It is the modern substitute for the shadûf, mental, picotah, noria, wheel with pots, etc.

The pump is fixed on a staging over a stream, and is driven by a portable engine. The boiler has a fire-box considerably larger than the ordinary portable engines, and where coal is expensive, as in Egypt, and there is an abundant supply of cotton stalks, maize, etc., great economy is obtained by feeding this vegetable matter into the fire-box by the straw-burning apparatus, driven by a strap from the crank-shaft, as shown in the engraving. The traveling wheels are made entirely of iron, and are not affected by excessive heat or the attack of insects. The pump shown in the engraving has double suction pipes. The pipes are made entirely of wrought iron, with a view of saving weight, and avoiding the inconvenience caused if a pipe is broken. The disk is accessible for examination without disturbing any of the joints.

The apparatus has, however, various other uses, such as in drainage, sheep-washing, emptying docks and dams, etc.

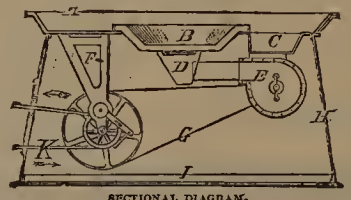
See also NORIA, Fig. 1819, p. 636, *supra*.

See also CENTRIFUGAL PUMPING ENGINE, Fig. 1218, p. 516, "*Mech. Dict.*"

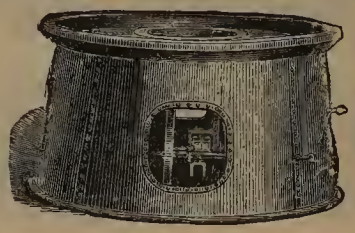
Port'a-ble Forge. A movable forge to be used in the field, on the march by pioneers, in the vicinity of temporary works, etc.

Two forms are shown in Figs. 2013, 2014. They are adapted to be driven by hand or power, having the necessary

Fig. 2013.



SECTIONAL DIAGRAM.



"*Keystone*" *Portable Forge.*

hand-wheels and power connections. The sectional view, Fig. 2013, shows the relation of the band-wheel *K*, band *G*, fan *E*, tuyere *D*, hearth *B*, quenching trough *C* and table *A*. *F* is the hanger of the band-wheel. The functions are similar, but the parts somewhat modified.

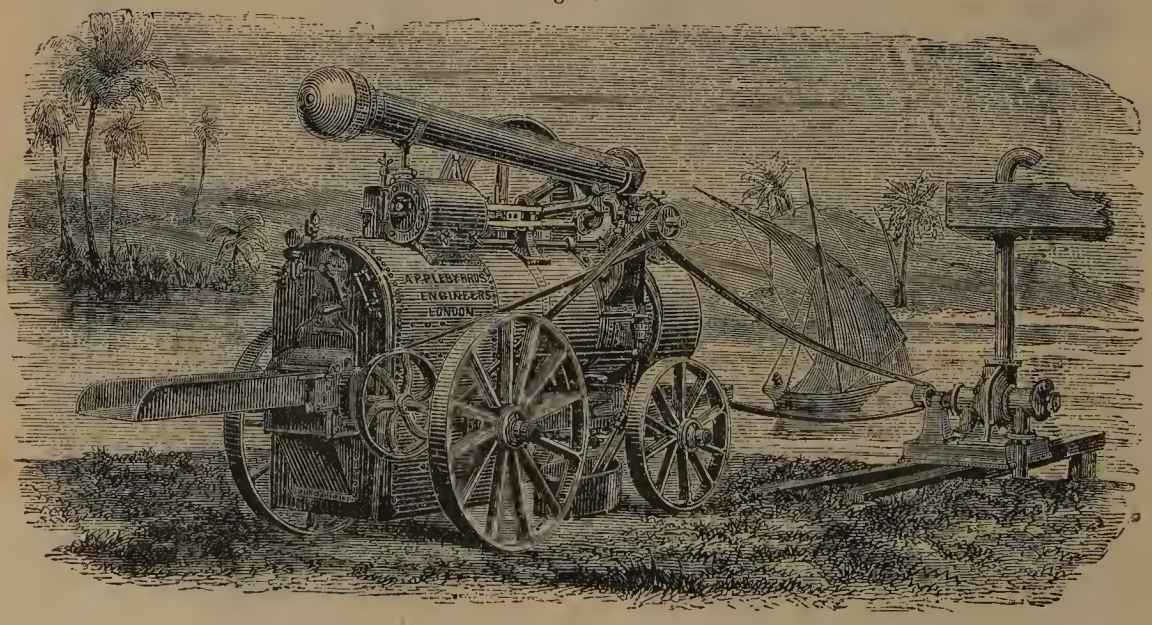
Fig. 2070, p. 905, "*Mech. Dict.*"

BATTERY FORGE, Fig. 597, p. 249, *Ibid.*

FORGE, Figs. 1084, 1085, p. 354, *supra*, and references, *passim*.

Port'a-ble Fur'nace. One which is transportable, as in the case of charcoal furnaces for domestic or plumbing purposes.

Fig. 2012.



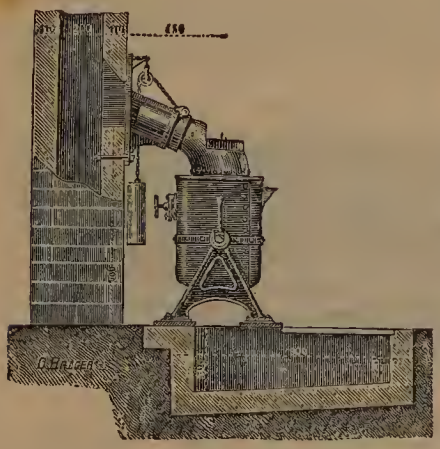
Portable Engine Pump.

Fig. 2014.

Portable Forge.

A more important example, however, is the oscillating crucible furnace of M. Piat.

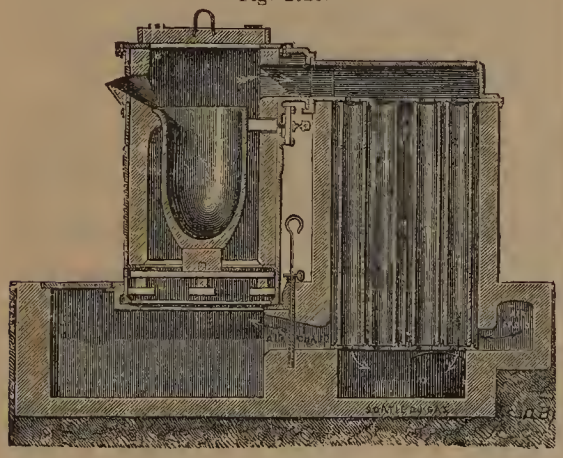
Fig. 2015.



Piat Portable Furnace.

It is shown in partial elevation and section in Fig. 2015, and in perspective under CRUCIBLE FURNACE, Fig. 737, p. 233, *supra*.

Fig. 2016.



Piat Furnace, with Regenerator.

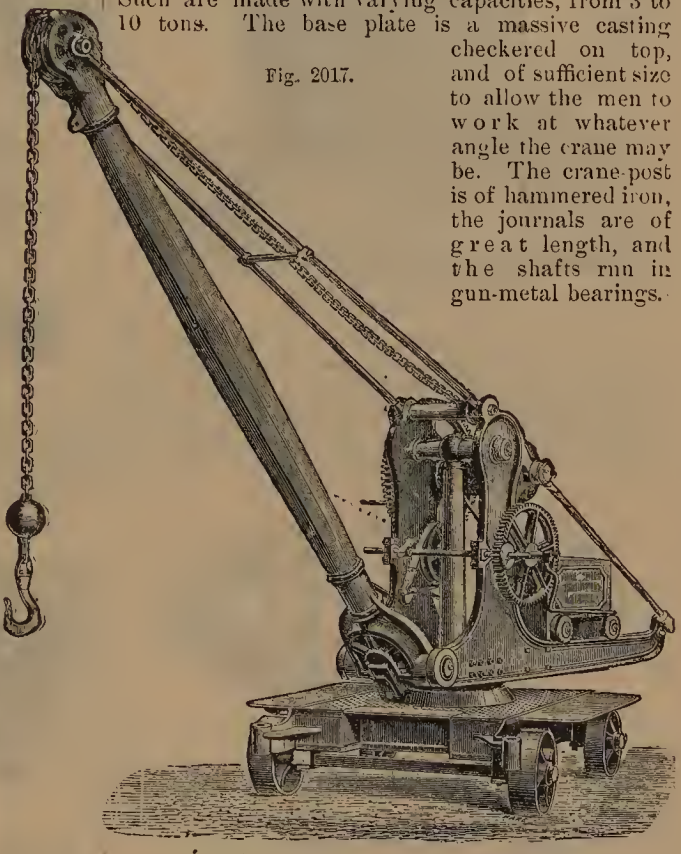
The crucible is permanently inclosed within the furnace wall, and the two are moved together, whether to the furnace and chimney, or to the molds on the floor of the foundry. The mode of heating is either by combustible placed between the crucible and the furnace wall, the ashes from which fall through holes in the furnace when the crucible is over the draft, or the heated gases from a gas producer are led to the furnace (Fig. 2016), passing through the regenerator which is heated by the gases escaping from the furnace in the direction of the upper arrow.

The furnace containing the crucible is moved on wheels, as in Fig. 735, p. 233, *supra*, or is slung from a crane.

Piat, Fr. . . . . * "*Engineer*," xlix. 260.
* "*Engineering*," xxviii. 397.

Port'a-ble Hand'-crane. A crane on a truck. Such are made with varying capacities, from 3 to 10 tons. The base plate is a massive casting checkered on top, and of sufficient size to allow the men to work at whatever angle the crane may be. The crane-post is of hammered iron, the journals are of great length, and the shafts run in gun-metal bearings.

Fig. 2017.



Appleby's Three-ton Portable Hand-crane.

The balance-weight box is moved along the tail-pieces by a traversing screw worked by a hand-wheel. There is a friction roller to take the weight off the back balance and to reduce friction in turning. The illustration shows a three-ton crane.

Port'a-ble Mill. A military or pioneer's mill.

See ARMY MILL, Fig. 111, p. 47, *supra*.
Aubin . . . * "*Scientific American Sup*," 3756.

Port'a-ble Pump. A pump for irrigation, extinguishing fires, for green-house purposes, watering lawns, etc.

See under various titles. Such as HYDRONETTE, AQUAPULT, etc.

In a smaller form a STOMACH PUMP, INJECTOR, SYRINGE DOUCHE, etc., which see.
In one sense, a FIRE ENGINE, which see.
Fig. 2018 shows a French portable pump and tank.
See IRRIGATION PUMP. Figs. 1473-1475, p. 508, *supra*.
See NORIA; PORTABLE ENGINE AND PUMP, *supra*.
Also Fig. 1218, p. 516, "*Mech. Dict.*"

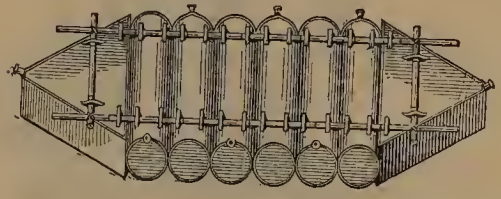
Port'a-ble Raft. One capable of transportation on a journey as distinct from one simply hove overboard from a ship, or made in an emergency from masts, casks, and other floating material. See Figs. 4105-4108, pp. 1854, 1855, "*Mech. Dict.*"

Fig. 2018.

French Portable Pump.

The life-raft, as shown in Fig. 2019, is of a form that might wisely be adopted for use nearer home. Stanley's portable raft was composed of six caoutchouc ponton tubes, which were inflated at pleasure by means of bellows. These tubes rest transversely on three keels, to which are lashed the poles shown above. The bow and stern consist of triangular compartments, and the whole during transportation may be

Fig. 2019.



Stanley's Raft.

packed in a convenient form. Its whole weight is 300 pounds, which can be divided into five loads of 60 pounds each.

See also RAFT, "*Mech. Dict.*," *et infra;* LIFE BOAT, Fig. 1588, p. 542, *supra;* PORTABLE BOAT, *supra.*

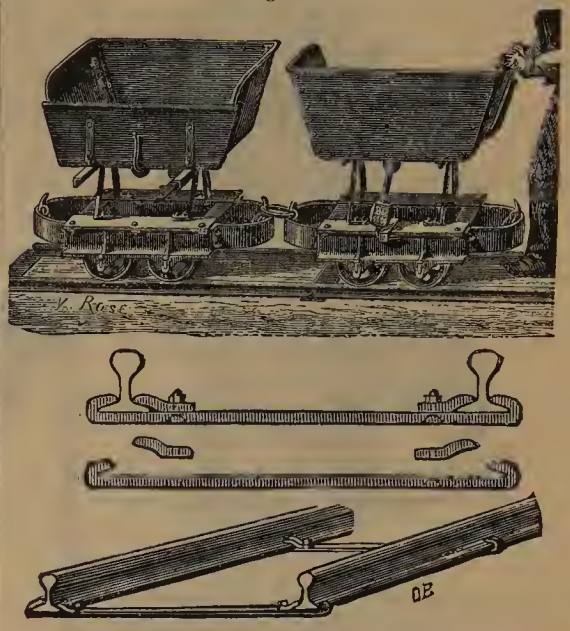
Port'a-ble Rail'way. A system having tracks in section laid down on plantations, in wine caves, or in manufacturing establisements, for conveyance of crops, heavy articles, packages, and what not.

Fig. 2020.

Decauville's Portable Railway.

The system shown in Figs. 2020–2022 is that of *M. Decauville*, of Petit-Bourg, near Paris. The rails have iron ties laid

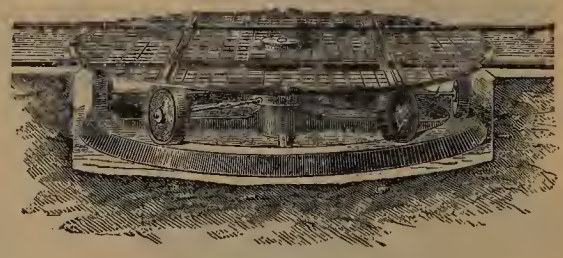
Fig. 2021.



Portable Railway Trucks, Rails, and Track.

in sections of track 5 meters long, more or less, with switches, turn-outs, and turntables, according to the requirements of the special case. It is evident that while in field-railways a curve may be admissible, it will frequently be necessary to substitute a turntable in the passages of a yard or building.

Fig. 2022.



Turntable.

The trucks shown are dumping cars used in plantation use for conveying beets especially from the field to the sucrerie or distillery. Other forms are used in wine caves and in factories and for cane plantations.

Fowler, Br. . . . . * "*Engineer*," xlviii. 34.

Port'a-ble Steam Crane. A locomotive steam crane. Used in factories and many public and private works of the larger class.

The crane shown in Fig. 2023 was used in dismounting heavy freight from flat cars at the Paris Exposition, 1878.

The Aveling & Porter portable steam crane is a modification of their traction engine, having the same locomotive power with the addition of the winding drum and crane. The foot of the jib is rigged in front, resting upon the front base-piece of the boiler, and the top is supported by iron rods which are attached to the side plate brackets. The sides of the fire-box are extended upward to form the crank shaft brackets.

See, also, RAILWAY CRANE, *infra;* STEAM CRANE, "*Mech. Dict.*"

Port'a-ble Steam En'gine. One capable of moving or being moved from place to place. They are known by various specific names, according to purpose, usually. See various captions under PORTABLE ENGINE.

See also PORTABLE STEAM ENGINE, Figs. 3895–3899, pp. 1769, 1770, "*Mech. Dict.*"

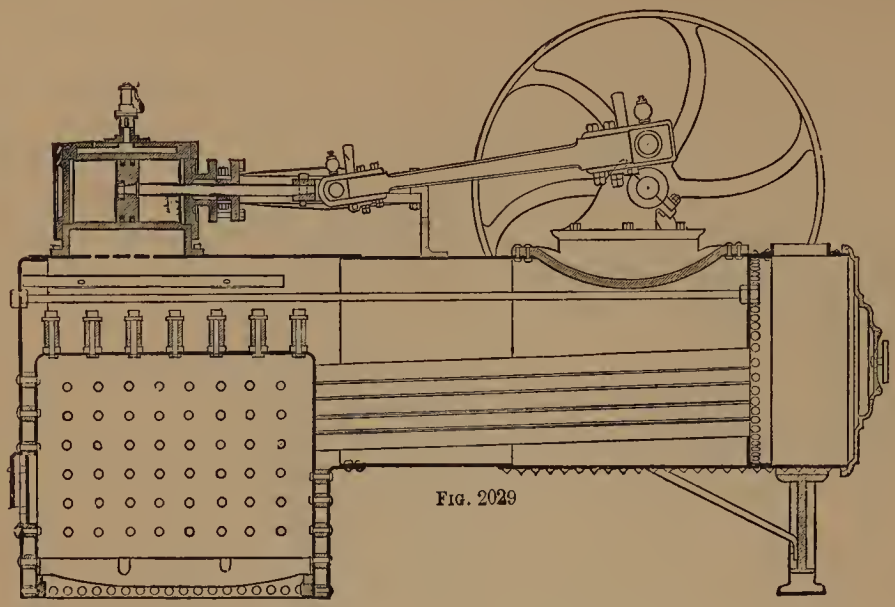


Fig. 2029

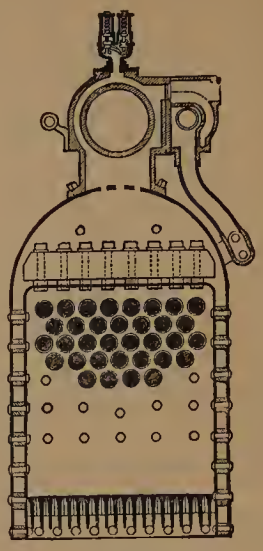


Fig. 2030

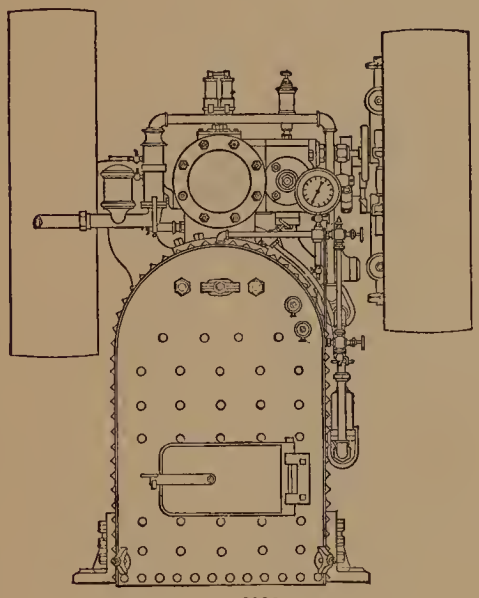


Fig. 2026.

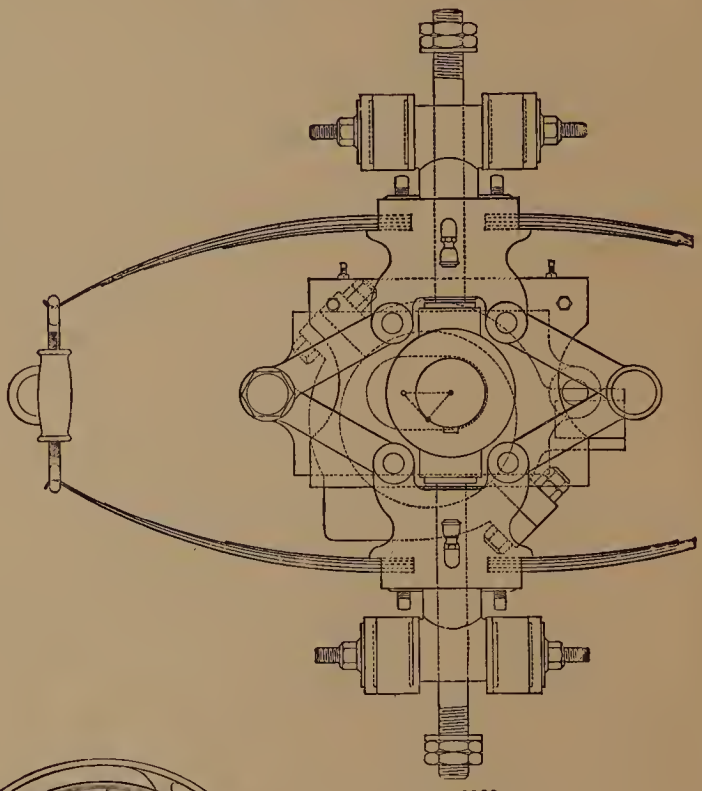


Fig. 2028.

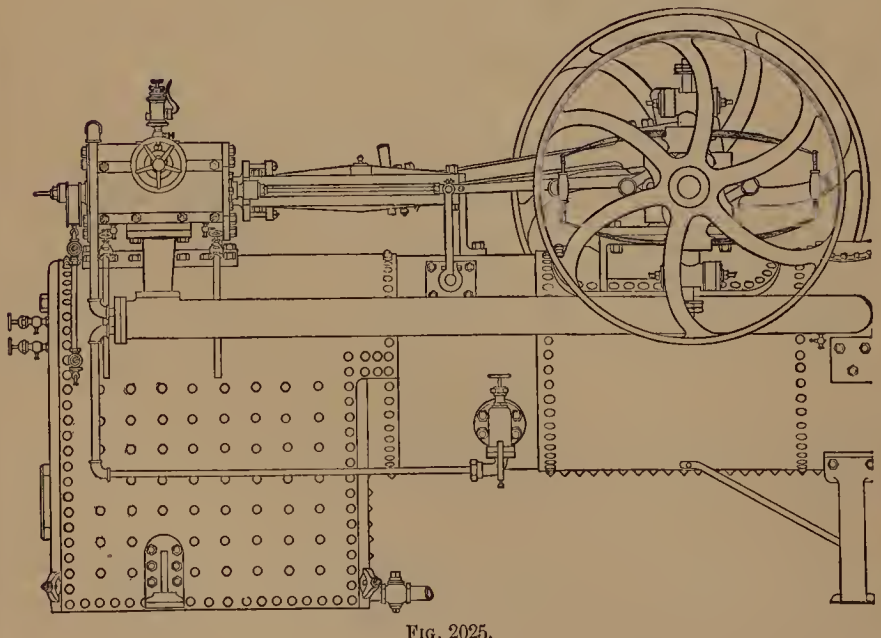


Fig. 2025.

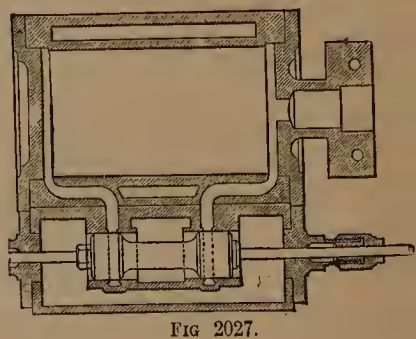
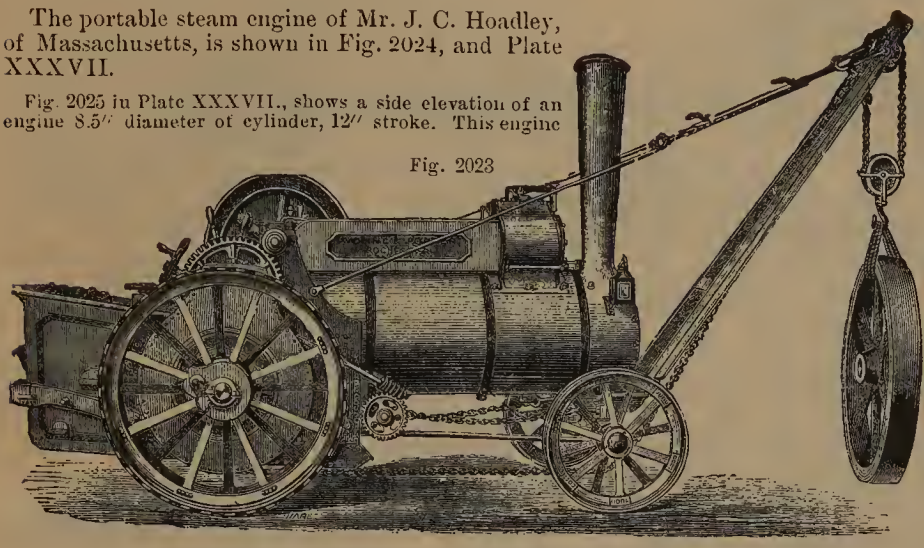


Fig 2027.

The portable steam engine of Mr. J. C. Hoadley, of Massachusetts, is shown in Fig. 2024, and Plate XXXVII.

Fig. 2025 in Plate XXXVII., shows a side elevation of an engine 8.5″ diameter of cylinder, 12″ stroke. This engine

Fig. 2023



Aveling & Porter's Portable Steam Crane.

gives 20 indicated horse-power with 100 pounds per square inch steam gage pressure in the boiler, and four-fold expansion. The boiler easily supplies steam for 25 indicated horse-power.

Fig. 2026 shows the fire-box end of an engine 8.5″ diameter of cylinder, 12″ stroke, in end elevation.

Fig. 2027 is a horizontal section on the axis of cylinder and steam chest of an engine 8.5″ diameter of cylinder, 12″ stroke.

Fig. 2028 is a side elevation on the larger scale of the governor of an engine 3.5″ diameter of cylinder, 12″ stroke. The leaf springs are straight when unconfined by the links at their extremities. The centrifugal force of the springs, of the sliding heads which confine their thicker ends, and of the adjustable weights attached to these sliding heads, causes the heads to slide outward, toward the binding-nuts at the upper and lower ends of these rods, thereby increasing the tension of the springs, and shifting the eccentric, by means of the toggle-joint at the left-hand, and the sliding-plate to which the eccentric is fast, cast solid with it.

The sliding-plate and eccentric are slotted, as shown by dotted lines. The slot is long enough to admit of shifting the sliding-plate to the other toggle-joint, at the right, which reverses the engine.

Fig. 2029 is a vertical, longitudinal section, on the axis of a similar boiler and engine.

A spray-plate, indicated above the tie-rod, over the fire box, prevents the direct admission of entrained water to the jacket around the cylinder.

Fig. 2030 is a vertical cross section through fire-box and cylinder of an engine 8.5″ diameter of cylinder, 12″ stroke.

An engine of the class represented in the accompanying cuts, and of the same arrangement and construction, was tested at the International Exhibition in Philadelphia, Sept. 7, 1876, under the direction of John S. Albert, Chief of Bureau of Machinery, by Charles T. Porter, Charles E. Emery, and Joseph Belknap, Judges.

An ordinary, commercial engine, made and subsequently used to drive a saw-mill, it was destitute of all the refined appliances for saving heat and for obtaining unusual duty almost universal in trials of this kind. The boiler was entirely naked, and exposed a radiating surface equal to 40 per cent. of its heating surface, to a draft of cool, damp air. The loss caused by this radiation has been found experimentally to be at least 12 per cent.; and about 7-12 of this loss might have been saved by a simple boiler clothing.

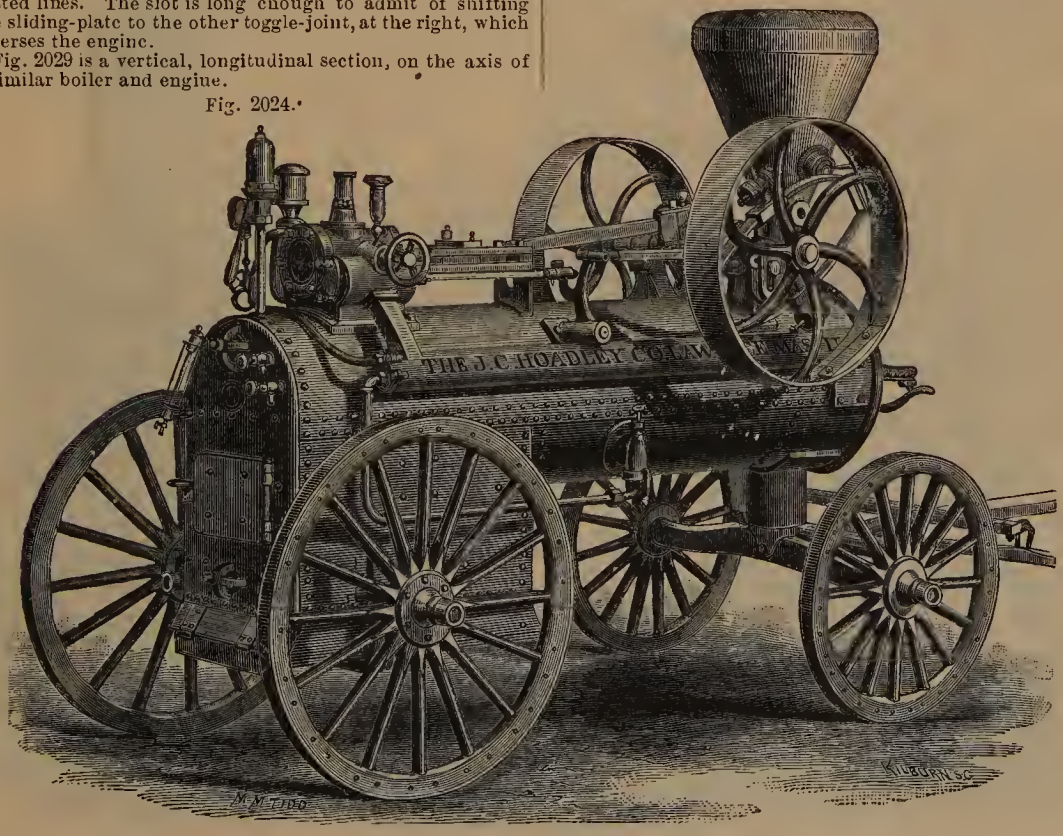
The ordinary anthracite used was wet by rain in transit to the engine, and was fired without special skill by a man who never before saw the engine.

All the conditions were arranged so as to represent the ordinary practice of men commonly using this class of engines. All these circumstances should be borne in mind in comparing results with those obtained by exceptional skill and care from "racing engines."

CONSUMPTION.

For each indicated horse-power during one hour: —

Fig. 2024.



Hoadley's Portable Steam Engine.

25.61 pounds of feed-water, by weight.
19.38 pounds of visible steam, by diagram.
3.35 pounds of anthracite coal.
2.95 pounds of combustible.

GENERAL DIMENSIONS.

Engine.

Diameter of cylinder	14.56″
Diameter of piston-rod	2.375″
Length of stroke	1.66′
Capacity of clearances and passages in terms of stroke	.091

Boiler.

Length of shell	16′
Diameter of shell, inside	40″
Length of fire box, inside	54″
Width of fire-box, inside	34″
Height of fire-box, above grates (whole height, 48″)	44″
Number of tubes	80
Diameter of tubes, outside	2.25″
Length of tubes (between tube-sheets)	113″
Heating surface in fire-box above top of grates, square feet	60.5
Heating surface, tubes, inside, square feet	394.5
Heating surface, smoke-box, square feet	6.5
Heating surface, aggregate, square feet	461.5
Area of fire-grate, 54″ by 34″, square feet	12.75
Ratio of heating surface to fire-grate area	36 2

SUMMARY OF RESULTS OF TRIAL.

Kind of Quantities.	*Pounds.*
Feed-water per dynamometer horse-power, per hour	28.27
Feed-water per indicated horse-power, per hour	25.61
Visible steam per dynamometer horse-power, per hour	21.40
Visible steam per indicated horse-power, per hour	13.38
Coal burned per dynamometer horse-power, per hour	3.69
Coal burned per indicated horse-power, per hour	3.35
Combustible burned per dynamometer horse-power, per hour	3.26
Combustible burned per indicated horse-power, per hour	2.95
Water evaporated per pound of coal burned	7.65
Water evaporated per pound of combustible burned	8.68

EFFICIENCY.

The indicated horse-power is obtained from 300 to 350 pounds of engine and boiler.

The portable horizontal trade engine of Marshall, Graves & Co., is shown in Plate XXXVIII.

The parts are plainly visible, and scarcely need description. The boiler is of the locomotive pattern, with arched crown sheet braced and stayed. The water front extends around the fire-box and ash-pit. The boiler and engine are so far independent of each other that the expansion of the former in heating up brings no strain on the latter. The valve has variable expansion arrangement. The spark arrester has a steam spray. The wheels are of iron, and turn under the boiler. The bed plate forms the heater, and is bolted to the boiler on the cylinder end. The pump is worked directly from the cross-head.

The portable and traction engine of Hooven, Owens, Reutschler & Co., is shown in Plate XXXVIII.

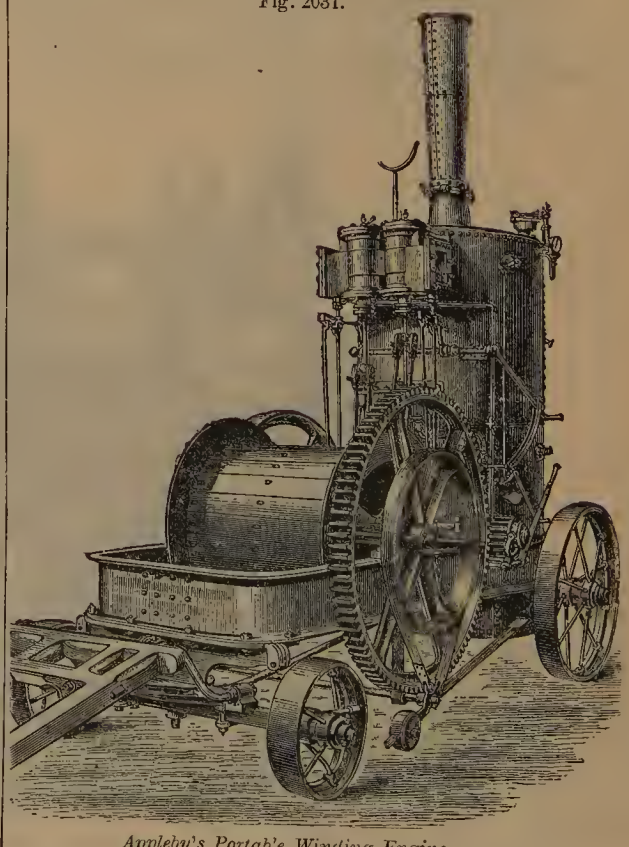
The engineer stands upon the rear plate, and has the starting and reversing levers, and the steering wheel immediately in front. The train by which the relatively rapid piston motion is geared down to the propulsion movement is principally upon the other side of the machine, as shown in the cut; but parts of it are visible above and below the boiler, and the pinion which actuates the spur wheel of the driver is on the side presented. When the engine is in place, the locomotive portion is thrown out of gear, and the force of the engine applied to the band wheel.

Several forms of portable steam engines, locomotive (self-moving), and otherwise, are shown on p. 1770, "*Mech. Dict.*;" also semi-portable at Fig. 3895, p. 1769. The smaller class of engines, such as the Baxter, Fig. 3898, p. 1770, are light in weight, and, in a sense, portable, but not according to the proper meaning of the word as applied in this connection.

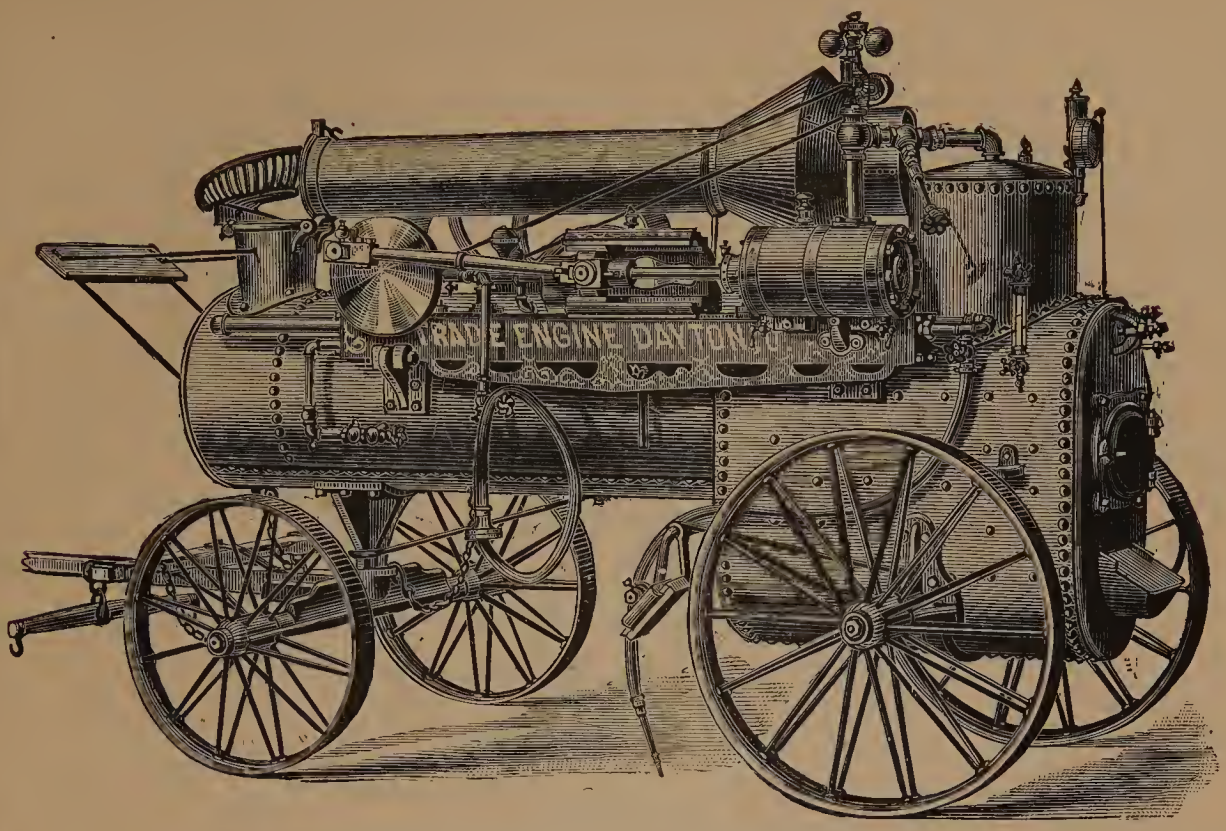
See the following references: —

Ransome, Br.	* "*Engineer*," xlvi. 407.
Marshall, Br.	* "*Engineering*," xxii. 463.
"Eclipse," *Frick*	* "*Scientific American*," xxxvi. 95.
Westinghouse	* "*Scientific American*," xlii. 115.
Wallis & Steevens	* "*Scientific American Sup.*," 1475.
Portable, *Ames*	* "*Min & Sc. Press*," xxxiv. 112.
	* "*Engineer*," xlii. 6.
	* "*Iron Age*," xix., March 22, p. 1.
	* "*Iron Age*," xx., July 12, p. 1; Aug. 2, p. 1.
Armitage & Ruster, Br.	* "*Engineer*," xlii. 203.
Baxter	"*Scientific Amer.*," xxxviii. 70.
Boiler, *Belleville*	* "*Engineering*," xxv. 387.
Blake, Br.	* "*Engineer*," xlviii. 181.
Brake, *Garrett*, Br.	* "*Engineering*," xxx. 44.
Engine, *Brown & May*, Br.	* "*Engineering*," xxiii. 448.
Cambridge	* "*Engineer*," xlvii. 466.
"Clipper,"	* "*Iron Age*," xviii., Dec. 21, p. 1.
Cochran, Br.	* "*Engineering*," xxx. 9.
	* "*Engineer*," 1. 39; xlviii. 45.
Demenge, Fr.	* "*Engineering*," xxviii. 338.
Erie Iron Works	* "*Iron Age*," xix., April 26, p. 1.
Boiler, *Garrett*, Br.	* "*Engineer*," xlvi. 226.
Engine, *Gibbons*, Br.	* "*Engineer*," xlviii. 434.
Hornsby (1849), Br.	* "*Engineer*," xlvii. 459.
King	* "*Min. & Sc. Press*," xxxvi. 81.
Longrove	* "*Iron Age*," xix., March 1, p. 1.
Mills	* "*Scientific Amer.*," xxxvi. 303.
Mud plug for portable engines, *Clayton & Shuttleworth*, Br.	* "*Engineer*," xlix. 53.
	* "*Engineering*," xxx. 233.
At Paris, 1867	* "*Engineer*," xlviii. 16.
"Peerless," *Landis*	* "*Iron Age*," xxi., May 16, p. 1.
	* "*Scientific American*," xlii. 68.
	* "*Scientific Amer.*," xxxviii. 190.
Ransome, Br.	*Thurston's* "*Vienna Rept.*," ii. 102.
Ransome (1841)	* "*Engineer*," xlvii. 459.
Self-moving	* "*Engineer*," xlvii. 459.
Skinner & Wood	* "*Scientific American*," xlii. 82.
Talbot, Br.	* "*Engineer*," xlvii. 416.
Utica St. E. Co.	"*Iron Age*," xvii., Jan. 6, p. 3.
Wallis & Steevens, Br.	* "*Engineering*," xxii. 467.
	* "*Engineer*," xlii. 382.
Wallis & Steevens, Engl.	* "*Scientific American Sup.*," 950.
Wheeler & Mellick	* "*Am. Man.*," July 16, 1880, p. 13.
Compound, *Fowler*, Br.	"*Iron Age*," xxiv., July 31, p. 13.
Engine of the future	"*Scientific American Sup.*," 1555.
Expansion gear.	
Marshall, Br.	* "*Engineering*," xxviii. 4.

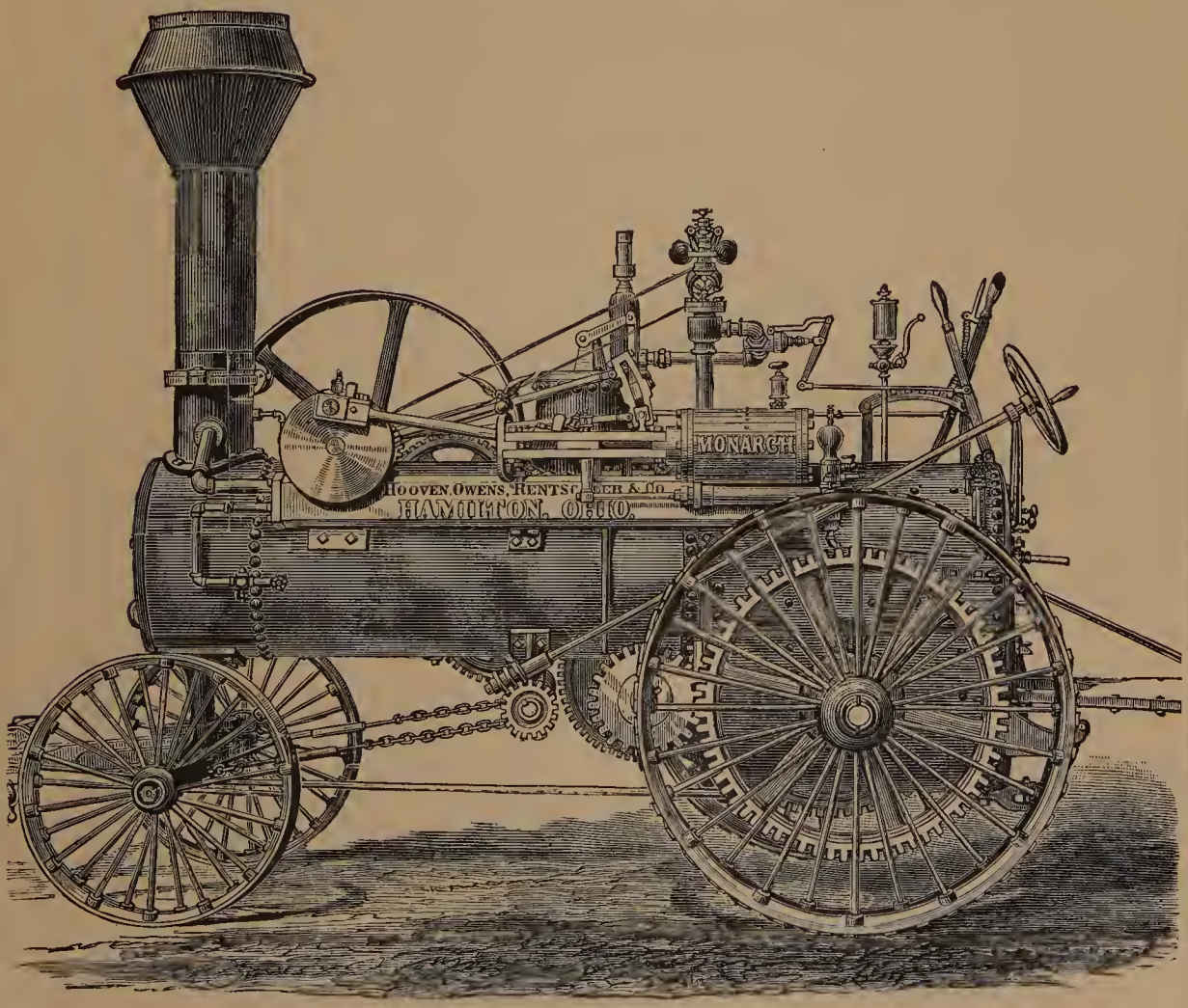
Fig. 2031.



Appleby's Portable Winding Engine.



MARSHALL & GRAVES' PORTABLE STEAM ENGINE.



HOOVEN, OWENS, RENTSCHLER & CO.'S PORTABLE AND TRACTION ENGINE.

See page 712.

Garrett, Br.	* "*Engineering*," xxviii. 25.
Straw-burning, *Clayton & Shuttleworth*, Br. .	* "*Engineering*," xxvii. 572.
Garrett, Br. . . .	* "*Engineering*," xxvii. 573.
	* "*Engineering*," xxiv. 36.
Vertical, *Baxter* . . .	* "*Iron Age*," xxi., May 2, p. 5.
Blymm Co.	* "*Iron Age*," xxi., Feb. 14, p. 9.
	* "*Iron Age*," xx., Dec. 27, p. 1.
Ervien	* "*Iron Age*," xxi., May 9, p. 39.
Farquhar	* "*Iron Age*," xxii., Dec. 12, p. 5.
Shapley	* "*Iron Age*," xxii., July 25, p. 1.

Por'ta-ble Wind'ing En'gine. A movable hoisting engine used in many temporary works, either buildings or excavations.

The forms vary with the purpose and the power required.

The instance given in Fig. 2031 is a 12 horse-power, used in railway works. It is mounted on wrought-iron wheels, and fitted with shafts and locking plate. The engine is fitted with link reversing gear, so that an up or downcast cast or double rope can be worked, or lowering may be performed by steam or by the brake. The drum and gear can be readily removed when the engine is to be used for driving machinery.

Porte-ac'id Glass. (*Surgical.*) A small burette to carry a caustic, for application in a deep-seated part.

Porte Ai-guille'. A needle holder.

Fig. 2032.

Porte Aiguille.

See Needle Forceps, Needle Holder, *supra;* and Fig. 3306, p. 1518, "*Mech. Dict.*"

Porte Pol'ish-er. An instrument for use with the Dental Engine, Fig. 795, p. 250, *supra.* It

Fig. 2033.

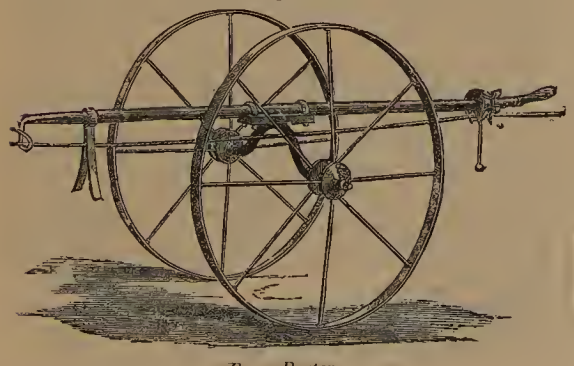
Porte Polisher and File Carrier.

may be considered a kind of chuck; a split screw, which allows the use of different sized points, and their retention by a turn of the sheath. — *Klump.*

Por'ter. Porters are wheeled supports placed along the line of the rope at intervals of 40 yards, to keep the rope off the ground in steam plowing. In another form they are mounted on three wheels, so as to allow them to be moved sideways by the rope.

The *Aveling and Porter's* traveling rope porters are fastened to the rope at intervals behind the plow or cultivator, as it leaves either headland; they travel across the field with the rope, and are taken off as they return. Their release from the rope is instantaneous. They are much less trouble than porters on any other principle, and they save the boys the fatigue of running with the implement across the field. The one which immediately follows the plow or cultivator is provided with a steerage, to prevent those behind from running on the plowed ground, and to keep the back rope clear of the furrow.

Fig. 2034.



Rope Porter.

See Installation of Steam Plow, pp. 2354, 2355, "*Mech. Dict.*"

Port'land Ce-ment'. A favorite hydraulic mortar made from the quarries of the hill of Portland, South Britain.

See Hydraulic Cement, p. 508 and 1144, "*Mech. Dict.*" Also Cement Tester, p. 184, *supra.*

Tests of, *Mann* . . .	"*Van Nostrand's Mag.*," xvii. 17.
	"*Sc. American Sup.*," 1333, 1427.
	"*Scientific Amer.*," xxxvi. 227.

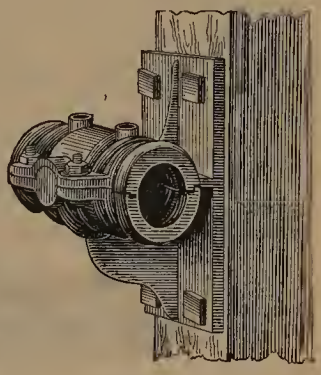
Por'trait Lathe. A lathe adapted to copying busts. It is a species of lathe for turning irregular forms, and depends principally upon the primary suggestion first embodied in useful service by Brunel in his block-making machinery in 1804, and Blanchard's spoke lathe, 1828.

See some data, pp. 1263, 1264, "*Mech. Dict.*," and discussion under article "*Sculpture par procédés Mécaniques*," vol. iii., *Laboulaye's* "*Dictionnaire des Arts et Manufactures*," ed. 1877. Also *Ibid.*, iv., "*Tours Composés.*"

Pos'i-tive. (*Electricity.*) In the battery, the zinc plate or element.

Post Box. A shafting box attached to a post, instead of to hanging or standing pedestal.

Fig. 2035.



Post Box.

Post Drill. One supported on a standard. See Lever Drill, Fig. 1584, p. 541; Pillar Drill, Fig. 1931, p. 681, *supra.*

Post Mor'tem Table. One for autopsy, dissections, etc.

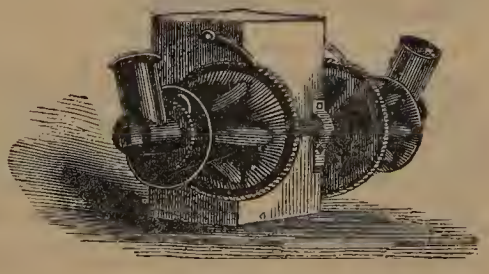
A table about 6½′ × 2½′ and slightly dishing towards a perforated plate in the center, at which water and blood are carried off by a trapped pipe to the sewer. The same pipe carries off fetid air.

The table revolves, also raises and lowers, and rests upon a scales in the pedestal which has beams reading to pounds and ounces. — *McIlroy.*

Post Pumps. A form of donkey pump, attached to a port. See Pendulum Pump, *supra.*

Post Wind'lass. A winding machine which is actuated with breaks or handspikes by a recip-

Fig. 2036.



Post Windlass.

rocating movement. In the special case it is a windlass of small size and the mode of mounting accounts for the name.

Pot. 1. (*Glass.*) The crucible in which *frit* is melted to form glass.

Glass pots are open or closed, the latter to protect fine qualities of glass, such as flint, from impurities.

In France and Belgium pots for cylinder glass usually contain 1,000 to 1,200 pounds of glass; in England sometimes as much as 5,000 pounds.

Furnaces usually hold 8 pots. It is a common European practice, and not unknown in America, to make pots thin and replace them regularly at the end of the week; instead of making them thicker to give them a longer lease of life.

The batch is put into the pots in three lots, allowing each to melt before adding another. The allowance of melting time, with a class of large pots is

For the first charge	7
For the second charge	4
For the third charge	3

2. (*Fishing.*) The *bow*, *pound*, or *crib* of a *pound-net*, which see.

Po-tas'si-um-chlo'rate Bat'te-ry. (*Electricity.*) One in which potassium-chlorate with sulphuric acid is used as the depolarizer.

	"*Niaudet*," American translation, 210.
Potassimeter	"*Potassimère*," *Laboulaye's* "*Dict.*," iii.
Potassa, industry	"*Scientific American*," xxxiv. 260.

Po-ta'to Bug De-stroy'er. A device for sprinkling or dusting poison upon the beetles, or sweeping them off the plants into trays.

See list, where the devices of this nature are described, COTTON-WORM DESTROYER, p. 226, *supra*.

Po-ta'to Cov'er-er. A one-horse machine with flanged expanding sides that draw the soil from both sides and cover the potatoes, or other ridge crop.

Po-ta'to Dig'ger. Three forms of machines for digging potatoes are shown on pp. 1775, 1776, "*Mech. Dict.*"

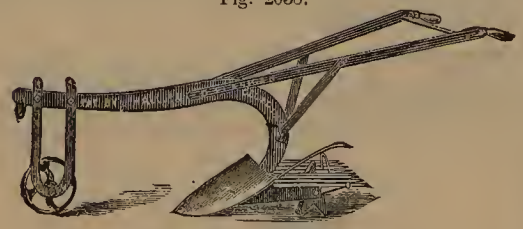
Those given in the accompanying Figs. 2037–2039, are respectively French (double effet.), American (*Speer*), British (*Permey*).

Fig. 2037.

French Potato Digger.

Their action is essentially different. One acts as a plow with lifting prongs to separate the tubers from the soil; an-

Fig. 2038.



American Potato Digger.

other plows up the tubers and soil and separates them by a dancing grating; the third has revolving forks which throw up soil and tubers against a dependant screen.

The "Empire" potato digger, *Allen & Co.*, is a machine in which a plow is succeeded by bent revolving forks which work through the furrow slice and sort out the potatoes from the soil.

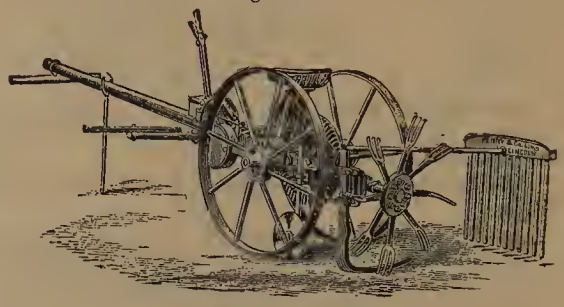
Avery's is a shovel plow with prongs extending behind the share.

Siedersleben, Ger.	"*Scientific American*," xli. 66.

Po-ta'to Ma-chin'er-y.

Beetle destroyer, *Badona*	* "*Scientific American Sup.*," 57.
Iske	* "*Scientific American Sup.*," 446.
Digger, Engl.	* "*Scientific Amer.*," xxxix. 182.
Fr. & Am., Paris, 1878	* "*Scientific Amer.*," xxxix. 165.
Liedersleben, Ger.	* "*Scientific American*," xli. 66.
Strait	* "*Scientific American*," xl. 67.
Taylor	* "*Scientific American*," xlii. 166.
Planter, *Murray*, Br.	* "*Engineer*," l. 61.

Fig. 2039.



British Potato Digger.

Po'tent. (*Horology.*) A journal plate or bearing in a watch.

Po'ten-tite. An explosive used in the Cumberland and Furness mines, England.

Pot'te-ry. (*Ceramics.*) Pottery is an inclusive term, and comprehends all the varieties of baked clay ware.

Ceramics and *ceramic art* are the scientific terms which include the whole art of making and ornamenting objects of clay.

Even bricks are a class of pottery and are only distinguished from tiles of a common order by their shape. Of the many millions of bricks of which the major part of ancient Rome was built, a large proportion would be termed tiles, if classed according to their shape.

The saying of Augustus that he "found Rome brick and left it marble," has its comment in the fact that the hordes who captured Rome "found it marble and left it brick," for the marble was generally but a covering of slabs which have generally disappeared. The baths of Caracalla and the basilica of Constantine, as examples, are enormous masses of brick walls, from which the white and colored marble veneering has disappeared.

Pottery takes two grand divisions: *soft* and *hard*.

Soft pottery may be divided into four kinds: —

1. *Unglazed:* simply made of baked clay, porous and without lustrous surface.

2. *Lustrous*, or semi-glazed, but imperfectly resisting water.

3. *Glazed*, having a shining surface which is proof against water and uncorrosive liquids.

4. *Enameled*, or having a vitreous and more incorrodible and impermeable surface.

While the archaic and technical interest of the first-named three varieties is very great, the latter includes the principal objects of interest in modern soft pottery manufacture and embellishment.

Soft pottery embraces *faïence* and *majolica*, from Faënza (in Italy) and Majorca, two localities where the art of decorating pottery flourished in times past; in the former, notably in the sixteenth century, and in the latter during the Saracenic occupation of the island.

Almost every nation in Europe is now struggling to lead in the making of faïence, and the influence of the works of Asia, from China, Japan, India, Arabia, and Persia have suggested compositions, designs, forms, colors, and objects which have greatly increased the variety and beauty of European productions.

Hard pottery, or porcelain, is of a more vitreous character than *soft* pottery. Its composition is materially different, and it approaches glass in its character. Porcelain, in breaking, shows a vitreous character, usually white, though the color depends upon the material. Soft pottery has a rough fracture, exposing the porous clay body. Porcelain has a much sharper ring when struck, its material being hard and homogeneous. Pottery is translucent; soft pottery opaque.

Porcelain is divided into *hard* and *soft* paste, indicative of the relative compactness of the material. This may be stated in a general way to be due to the proportions of silica. See PORCELAIN, *supra*.

Stone ware is practically a grade between porcelain and earthenware.

See list under CERAMICS, p. 186, *supra*.

Brogniart divides pottery into 3 classes and 9 orders: —

I. Tender paste; sandy clay, calcareous; generally fusible in a poreelaiu fire.	1.	Terra-eotta: brieks, tiles, and coarse earthenware. Sandy-clay ware, with dead surface, without glaze.
	2.	Lustrous pottery: thin silico-alkaline glaze.
	3.	Glazed pottery: lead glaze.
	4.	Euameled pottery (eommon faïeuce): tin glaze.
II. Hard paste. Argilo-silicious. Infusiblc.	5.	Fine faïence: uncolored paste; lead, glass glaze.
	6.	Stone ware: eolored paste, without glaze, or with silieo-alkaline glaze.
III. Hard paste. Translueent; argilo-siliceious; alkaliue.	7.	Hard porcelaiu: k aolinpaste, with feldspathie glaze.
	8.	Natural tender poreelaiu: paste argilo-saline, phosphatic, kaolinie; lead, glass, or boraeic acid glaze.
	9.	Artifieial tender poreelain: fritted marlaeeous saliue paste; lead-glass glaze.

I. 1. Fr. *Terre Cuite.* Thc ordinary and coarser kinds of pottery are made of plastic clay or argillaceous marl trauped, or ground in a pug-mill, and mixed with sand, lime, or ciuders, according to the quality of the clay. The drying of bricks is usually in the open air, but of other objeets sometimes in ovens.

The pr duee is an article open and porous, usually not very hard, and the objeets are unglazed.

This elass of pottery comprises: —

a. Brieks for building, not iucluding *fire bricks* (which see).

b. Tiles for roofiug and paving, not including glazed, enameled, and decorated. See TILE.

c. Stove and furnaee pots; though these are often of refractory material, and not of the material eited above.

d. Drain tiles, water pipes, and hollow bricks.

e. Common household pottery not glazed, such as the chafing dishes used in Europe.

f. Flower pots and horticultural vases.

g. Sugar molds.

h. *Alcarazzas*, or eooling jars for water; *hydrocérames.*

I. 2. Fr. *Poteries tendres lustrées.* The paste is fine, homogeneous, opaque, and of a red or yellow color; the surface covered with a luster or peculiar alkaline-silicious glaze, now of a reddish or a black color, very thin and resisting. The ware has a dull fracture, and was baked at a low temperature. The Greek, and some other aneient pottery, belongs to this elass, and it is not made now-a-days.

I. 3. Fr. *Poteries tendres vernissées.* This class includes the ordinary pottery before the making of *faience*, and is still eommon in many countries. The paste is of plastic clay or argillaceous marl and sand, with the addition of lime, when it is not present with the clay. The materials are ground, the objects baked under protecting hoods, the biseuit ware dipped in a slip of lead glaze colored with oxides of manganese or copper.

I. 4. Fr. *Poteries émaillés.* Common *faïence.* Probably invented in Persia; introduced by the Saraeens into Spain and Majorea (*majolica*); rediscovered in Italy by Luea della Robbia, born at Florence 1388 (*faïence*); and again by Palissy in the middle of the 16th eentury (Palissy ware).

Thc material of the paste is plastic clay, or argillaceous marl and sand. The clay is washed. The material is carefully mixed and milled, thc ware baked at two operations; one for the biseuit, and the other for firing after glazing. This is frequently done in the saue kiln, the crude being above, and the enameled ware below. The heat of the latter is a few degrees the hotter; the upper from a cherry to a dark red.

The enamel consists of a slip containing red lead, the oxides of lead and tin, sand, salt, soda, and coloring materials, and the ware is completed in a seeond fire. See FAÏENCE.

II. 5. Fr. *Faïence fine.* Invented by Wedgwood, in Staffordshire, England. The paste is white, opaque, of fine texture, dense, and the ware is sonorous. The glaze is a lead-glass. The material is essentially a washed plastie clay and calcined flints, or quartz finely ground, sometimes with a little chalk. Thc material of thc glaze is fritted, aud is composed of silex, soda, oxide of lead, and sometimes the addition of a little boracic acid.

Three principal kinds are distinguished, named from the notable quantities of ehalk, silex, and feldspar in their respective compositions; though some chalk always accompanies the plastic clay, whieh varies from 62 to 87 per cent. in the various pastes of fine faïence.

The elay or kaolin is washed, the silex broken and ground fine, the matters brought to a thin batter with water, strained, and consolidated by evaporation. The paste is placed in damp cellars to ripen.

The baking and firing are at two operations; the biscuit being glazed by dipping or sprinkling with a slip embraeing more or less of the following: feldspar, sand, kaolin, chalk, soda, boracic acid, ground glass, red lead, niter, and a little cobalt to connect yellow color. See FAÏENCE.

II. 6. Fr. *Grès-cérame* or *poteries de grès.* Stoue ware. Stone ware is solid, very hard, sonorous, and opaque, with a paste more or less fine, and is distinguished as *common* or *fine.*

a. The paste, of coarse stone ware, is of unwashed plastic elay and quartzose sand. The articles are molded or made on the wheel, according to the eharaeter of their shape. They are glazed by throwing marine salt into the kiln and into the fire at the period of great heat, and the decomposition of the salt eovers the objects with a thin scale of silieo-aluminate of soda.

In some cases the unglazed artieles are plunged in a bath of yellow oehre and fired; the resulting eolor is a brown-yellow glaze.

b. The composition and glazing of fine stone ware are essentially different. A feldspathie flux is added to the paste whieh makes it more vitreous, shown by its brilliant fracture. Kaolin, plastie clay, silex, pegmatite, sulphates of lime and baryta are used in the various pastes for stone ware. The glaze is sometimes by salt, potash, and red lead, placed in the seggars and volatilized in the kiln; or the biscuit is dipped in a lead-glass slip.

The articles are often ornamented by transfer-printing, or painting with metallie colors. See STONE WARE; PIPE.

III. 7. Fr. *Porcelaine dure.* Hard porcelain has a fine paste, is hard, translucent, sonorous, semi-vitreous, with a hard, earthy glaze. It is the most beautiful and resisting of all kinds of pottery.

The paste is composed of kaolin, feldspar, and sometimes of sand, plastic elay, and ground powder of pottery. The utmost eare in preparing and compounding the materials is exereised. The mode of fashioning is according to eharacter, the wheel, mold, and, in many eases, the art of the statuary.

After a slight drying in the air, the pieces are baked in the upper ehamber of the kiln, inclosed in seggars to prevent soiling by the combustion of the fuel. The glaze is of silex, alumina, potash, and ehalk, made into a fine slip in which the article is plunged.

Thc ware, after ornamenting in the biseuit stage, is burned at high temperature (*grand feu*) to vitrify the materials, giving the translucency and sonority. See PORCELAIN.

III. 8. Fr. *Porcelaine tendre naturelle.* English soft poreelain. This paste occupies a position betweeu fine *faïence* and hard porcelain, differing from the latter in having a large proportion of phosphate of lime. The paste is more plastic than that of the hard porcelain, and is fashioned like fine faïenee.

It is baked, and the biscuit glazed, ornamented, and fired in seggars. Thc glaze is lead-glass, with boraeic acid. See PORCELAIN.

III. 9. Fr. *Porcelaine tendre artificielle.* French soft porcelain. This was made at Sèvres until 1804, and then the manufaeture abandoned.

The paste is fine, dense, almost vitreous, hard, translucid, and fusible at high temperatures. A peculiar glass, fritted, forms three parts, to one part of marl and chalk, making a composition of little plasticity, which was moided. The difficulty of working it was extreme. The glaze was a glass: of sand, silex, litharge, potash, and soda. See PORCELAIN.

CERAMICS.

See: "*Wedgwood and his Works.*" *Meteyard:* London, 1873.
"*History of the Ceramic Art.*" New York, 1875.
"*Ceramic Art at the Vienna Exposition.*" *Blake:* New York, 1875.
"*Report of Ceramics at Paris Exposition*, 1878." *Blake*, United States Report, 1880.
"*Two Centuries of Ceramic Art in Bristol.*" *Champion:* London, 1873.
"*History of the Ceramic Art.*" *Jacquenard:* New York, 1873.
"*Keramic Art of Japan.*" *Audsley & Bowes:* 1875.
"*Pottery and Porcelain.*" *Prime.*

History, Development, etc., of the Ceramic Art, by Hector Tyndale, "*Centennial Exhibition Report,*" vol. iii., Group II., p. 2.

On the Chemistry and Composition of the Porcelains and Porcelain Rocks of Japan, by *Henry Wurtz, Ibid.*, 114.

See: Alhambra . . . * "*Scientific American,*" xl. 137.
American . . . . . "*Scientific American,*" xl. 57.
Ancient Roman . . . "*Iron Age,*" xx., Aug. 9, p. 3.
Gray pottery . . . . * "*Scientific American,*" xl. 264.
Greek ancient . . . . * "*Scientific American,*" xl. 199.
Japanese potters at work "*Scientific American Sup.,*" 1830.
Turkish pottery . . * "*Scientific American,*" xl. 361.
Potter's wheels . . . * "*Scientific American,*" xl. 226.
Pottery and porcelain . "*Scientific Amer.,*" xxxiv. 403.

Pou'dre Bru'tale. Coarse, or *cube powder.* Slow burning powder in blocks of determinate size, consisting, in some eases, of eubes 1.5″ thiek.

See PEBBLE POWDER; PELLET POWDER, *supra.*

Poul'try Feed'er. A revolving cylinder with coops in stories and in circuit, holding fowls which

are successively presented to the attendant, who crams each in turn. A French device. See EPINETTE, Fig. 974, p. 315, *supra*.

Poun'cing Ma-chine'. (*Hat Making.*) A machine for shaving or rubbing the surface of a hat or hat-body to rid it of shaggy fibres. The abradant is usually sand paper.

These machines may be considered as next in importance, in hat making, to the hat-blocking machine, and are constructed on two principles.

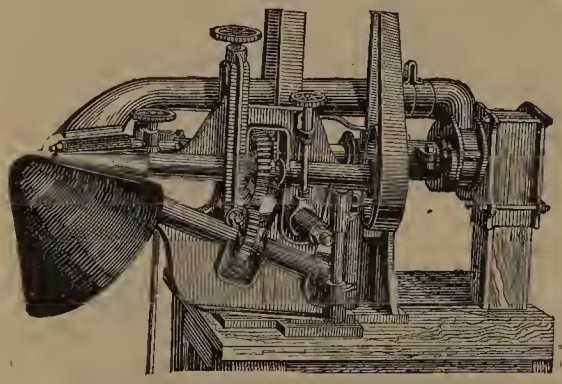
1. A rapidly revolving rubbing or cutting cylinder which operates on the object while it is fed along upon a yielding bed. This form is used on wool hats and the lower grades of fur hats.

2. A reciprocating motion is given to the rubbing surface or to the hat-body, to rub in two directions.

Fig. 2040 represents Eickemeyer's machine, which is used in both fur and wool-hat factories to sand-paper — or, as it is called in the trade, to *pounce* — hat-bodies when in the conical form, or, when the hat has been blocked, to pounce the brim.

It consists of a rotary cutting roller of conical shape which is driven from a countershaft above. This roller is covered with sand or emery paper, and on the opposite end of the roller-shaft is a fan, connected by a pipe which has a mouthpiece corresponding in shape with the cutting roller and directly over it, to carry off the fur or wool pounced off the surface during the operation. Under the cutting roller is a pouncing bed which is adjustable in two ways, namely, so as to set that part of its upper surface exactly parallel with the face of the roller and to vary its position when desired; and also to prevent its upward motion beyond a given point.

Fig. 2040.



Eickemeyer's Hat Shaving and Pouncing Machine.

The bed is pivoted in the rear part of the frame and is operated by a treadle, to facilitate the introduction and removal of the hat. A pair of conical feed rollers, supported in an adjustable swinging frame, which are also driven from the countershaft, furnish the feeding mechanism. The pouncing bed is raised by the treadle, after the hat has been introduced and grasped by the feeding rollers, until the hat-body is in contact with the cutting roller, after which the hat is guided by the operator until its surface is properly pounced.

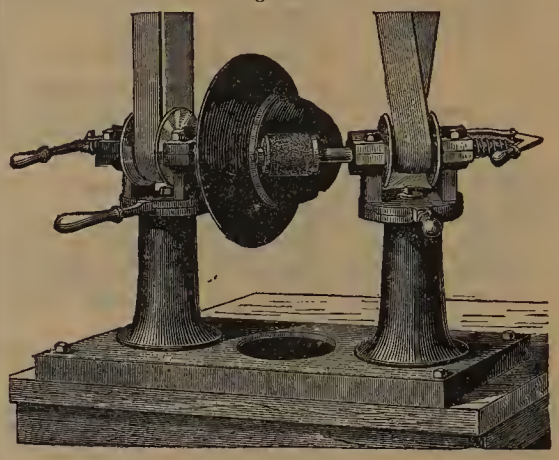
To pounce hat-bodies of different shapes, the position of the feed rollers has to be varied, and for this purpose a swinging frame is introduced which admits of an adjustment closer to or farther from the cutting roller as also in a direction parallel with the axis of the roller. An india-rubber spring presses the two rollers together, while the position of the feed-rollers relative to each other can be adjusted by a set-screw on the hinge-joint of that part of the swinging frame which carries the upper feed-roller.

The cutting rollers are usually made of metal, and, in this case, have a spline to hold the sand-paper, but when of india-rubber the sand-paper is glued in the shape of a conical ring which is held on the roller by the expansion of the rubber by means of a nut on the outer end of the spindle.

In wool-hat factories this machine is the only pouncing machine used, as all hats, even such as have been previously blocked, can be pounced, all but a very small piece on the tip, which is pounced when the hat is completed on the finishing lathe.

In the crown-pouncing machine of Wheeler & Manley, the hat is drawn upon a block which is rotated upon a lathe-spindle. This cutting roller has its bearings upon the outer end of a long lever which is pivoted upon a countershaft with a gimbal joint which allows a free motion of the lever in all directions, and enables the operator to bring the cutting-roller in contact with all parts of the crown. In the illustration the cutting-roller is shown as working upon the side-crown, and it is from that position slowly carried over the round edge and brought to bear upon the tip.

Fig. 2041.



Hat-crown Pouncing Machine.

Fig. 2041 represents the Labeaux hat-crown pouncing machine. It has two lathe spindles, supported upon two columns, in bearings which can be turned upon the center of the columns in a horizontal plane. The spindle which carries the hat-block has a slow motion while the roller spindle revolves rapidly. Both spindles can slide longitudinally in their bearings.

The hat is held upon the block by an india-rubber band, and, as both the spindles can be turned in a horizontal plane, and also brought nearer together and farther apart, the operator can bring the cutting roller to bear upon all parts of the side-crown and the tip.

These machines, as previously stated, are used for wool hats and for only the coarser grades of fur hats, and do not produce the fine surface required on the better grades of fur hat; for these, machines having a reciprocating motion are required.

In the *Eickemeyer-Rosecrans* machine the hat is placed upon an upright spindle having a reciprocating rotative motion. The spindle has its bearings in the frame of the machine, and at its lower part is enlarged, forming a roller of sufficient length and diameter to receive two bolts which are each fastened to one end of the roller and one end to a cross-head which is supported in two slides, also fastened to the frame. The slide receives a horizontal reciprocating motion from a crank on the main shaft of the machine. Every revolution of the crank causes the cross-head to wind up and unwind the belts alternately upon and from the roller, and thus causes the block to make a revolution in one direction and then in the other.

While thus in motion, sand-paper is held by the operator against the surface of the hat until the proper degree of finish is attained. Cutting first in one and then in the other direction produces a very short nap, which cannot be obtained when the cutting is done in one direction, as on a machine with a continuously rotating cutting roller.

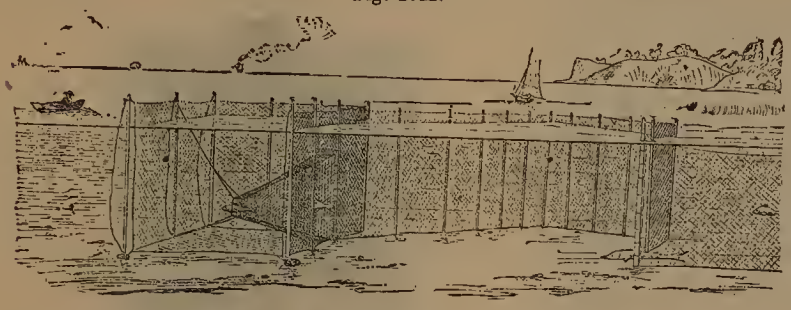
The brim-pouncing machine consists of a pair of rubbing plates, to which sand-paper is attached. These plates are made to vibrate in a horizontal plane in opposite directions to each other, by two cranks on the upright shaft which receives motion from the main shaft of the machine by a half-twist belt. The roller and the upper rubbing plate are raised to allow the introduction of the hat-brim. While the feed-rollers carry the hat around, one plate pounces the under side and the other plate the upper side of the brim. The result is a very smooth surface, and although but one fifth the number of hats can be pounced on this machine that can be pounced on the rotary cutter machine, it is by the manufacturers of fine hats preferred to the former.

The machine is provided with all the adjustments necessary to take up the wear of the working parts, and the upper plate and feed roller can be held up while in motion, so that it is not necessary to stop the machine to introduce and remove the hats.

Pound. (*Fishing.*) A wire or net inclosure into which fish are directed by a leader which intercepts their course along shore and conducts them to the first inclosure, known as the heart, from whence they pass through the tunnel to the more remote inclosure, the *pound* or *bowl*.

In emptying the pound the bottom stay-ropes are cast loose, the tunnel guys pulled up, closing the tunnel, the

Fig. 2042.

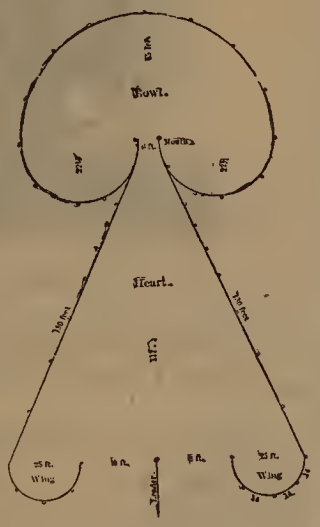


Pound.

bottom raised, driving the fish into one corner, when they are thrown into the boat by a scoop net.

Pound Net. (*Fishing.*) The *heart net* or *pound* consists of three parts, the *leader*, *heart*, and *bowl*, or *pound*, and is variously constructed.

Fig. 2043.



Pound Net, Wood's Holl, Mass.

The leader (of which a portion only is shown) is 265 yards long, reaches from the shore to the mouth, and directs fish passing along shore into the heart, whence they pass into the *bowl*.

The bowl is emptied once or twice a day.

For list of U. S. Patents, see FISHING NETS.

See other forms in "*Report of U. S. Fish Commission*," Part I., 1873, pp. 263, 264.

Pow'der Blow'er. (*Surgical.*) An instrument for blowing a powder upon a part. They are specially —

Aural.
Laryngeal.
Nasal.
Urethral.
Uterine.

See AUTO-INSUFFLATOR, Fig. 131, p. 57, *supra*; INSUFFLATOR, p. 501, *supra*.

Pow'der Dust'ing Ma-chine'. Gunpowder, whether pebble or granulated, is required to be clean, and the dusting operation intervenes between the pebbling or granulating and the glazing.

Dusting is performed in revolving cylindrical reels, with clothing of canvas or wire cloth of a fineness to suit the grade of powder. A reel 8′ long and 30″ diameter will have 40 revolutions per minute.

In Russia, the powder is dusted in bags. Fig. 26, accompanying Appendix L, "*Ordnance Report*," 1877.

See also "*Ordnance Report*," 1879, Appendix I., Plate IV., Fig. 9, and description on pp. 106, 107.

Pow'der-ing Ma-chine'. 1. A bronzing machine.

2. A pulverizer — which see.

Pow'der Pa'per. A substitute for gunpowder, invented in England.

Paper impregnated with a mixture of potassic chlorate, nitrate, prussiate, and chromate, powdered wood charcoal, and a little starch. It leaves no greasy residue on the gun, produces less smoke and less recoil, and is less impaired by humidity, and it is 5-16 stronger than gunpowder.

For a paper with fulminate, see Fig. 1151, p. 380, *supra*.

Pow'der Press'ing Ma-chine'. A machine in which the powder meal from the breaking-down machine is made into cakes. It is a hydraulic press, the box of which is 30″ × 14″, lined with oaken boards.

The powder has a thickness of 1¼″ between each of the consecutive plates, and is pressed to the determined extent. Pressed cakes, for breaking into pebble powder, are ⅝″ thick.

For ordinary powder, the cakes are broken with wooden mallets, and pass to the granulating machine.

Details of the pressing machine are given in Col. Laidley's report, "*Ordnance Report*," 1877, p. 441.

See also *Ibid.*, 1879, Appendix I., Plate III., Fig. 7; and description on p. 103.

In the St. Petersburg arsenal, the incorporated mixture is pressed into cake in two ways: —

1. By hydrostatic pressure.

2. By passing the mixture between two heavy iron rolls, while spread to a uniform thickness on an endless band of cloth. This is known as the Prussian method.

Pow'der Spoon. A small paddle with which a modicum of powder is applied to a deep-seated part, the uterus especially.

Pow'der Test'ing. In Britain, the chronograph is used to determine the velocity of the flight of the projectile, a given quantity of the powder under test being used in a service gun with a given ball.

In France, the test is in firing to extremity a cast-iron gun of a given model, made of a particular iron, and treated in a given manner, with charges of a fixed weight of the powder to be tested. A new gun of exactly similar character is used for each powder.

In Russia, the French *densimetre à mercure* is employed to test the gravity of powder. See DENSIMETER.

The subject is considered, *supra*, under INTERNAL PRESSURE GAGE; PIEZOMETER; CUTTER; DYNAMOMETER, etc.

In "*Mech. Dict.*," under EPROUVETTE; BALLISTIC PENDULUM; ELECTRO-BALLISTA: CHRONOSCOPE, etc.

Drying stove for testing samples, "*Ordnance Report*," 1879, Appendix I., Plate X *a*.

HYGROSCOPE, *Ibid.*, Plate X *b*.

Pow'er. As applied to a machine, signifies that it is moved by power, and not by hand: as *power press*, *power shears*, etc.

Prai'rie Plow. (*Agric.*) A plow with a broad, sharp share and long mold-board, for cutting a wide, shallow furrow, and completely inverting the furrow slice. A prairie breaker. See Fig. 422, p. 130, *supra*.

Fig. 2044.

Praxinoscope.

A California plow designed for work in the tules, which will cut a furrow 38″ wide. The mold-board is 8′ long from the point to the end, sweeping upward with a curve of about 4′ radius. At the end it stands 2′ above the ground. The land side is 7′ long. At the rear a horizontal cutting plate is arranged to cut under the sod on the land side a distance of 10″. The furrow depth is from 3″ to 4″. The plow is attached to a sulky, and requires a team of 12 horses.

Prai'rie Ren'o-va-tor. (*Agric.*) An implement with tearing harrow teeth, drawn over the surface of grass land to loosen the roots and the soil, dislodge moss, uproot weeds, and break up the matted vegetation.

Prax-in'o-scope. An instrument which depends for its effects upon the persistence of visual impressions on the retina. — *Reynaud.*

It however, differs structurally from a number of other instruments which depend also upon persis-

tent impressions. These are the ANORTHOSCOPE, PHENAKISTOSCOPE, STROBOSCOPE, THAUMATROPE, ZOETROPE. See under these titles in the "*Mech. Dict.*"

In the praxinoscope of M. Reynaud the pictures are placed on the inner perimeter of a polygonal box. These pictures represent the consecutive positions of a moving body and substitute each other incessantly, the series in the circle representing a cycle of movements. Turning around a common center there is a concentric polygonal prism formed of mirror plates, and having a diameter equal to the radius of the exterior polygon. The box carrying the pictures and the reflecting prism is revolved at a moderate speed by means of a crank, pulley, and cord.

In the evening the apparatus may be lighted by a lamp or gas flame, the light being reflected downward by a shade. The optical principle involved is explained by *G. Fussandier*, in "*La Nature.*"

Pre'puce In'stru-ments. (*Surgical.*) See PHIMOSIS INSTRUMENTS.

Press'es. See under the following heads: —

Arch screw press.
Baling press.
Blacking-box press.
Calendering machine.
Cane press.
Cheese press.
Cider press.
Compound cotton press.
Cork press.
Cotton press.
Cutting, drawing, and stamping press.
Double-tub press.
Drawing press.
Embossing press.
Forage press.
Fruit press.
Grape press.
Hay press.
Herbarium press.
Horn press.
Inclined press.
Jelly press.
Lever press.
Mangle.
Olive press.
Pebble powder machine.
Pellet powder machine.
Pendulum press.
Portable cider press.
Powder pressing machine.
Pressing machine.
Reducing press.
Screw press.
Shirt press.
Stamping press.
Tan press.
Tan-yard press.
Tincture press.
Tobacco press.
Toggle press.
Wire press.
Wiring press.

Dr. Knight's report on agricultural instruments at the Paris Exposition of 1878, gives descriptions and views of the following. See "*Paris Exposition* (1878) *Reports*," vol. v., pp. 223, 238. The list includes various kinds: —

Grape mill, *Mabille Frères*	France.
Cider or oil press, *Mabille Frères*	France.
Constant movement for agricultural presses, *Bodin*	France.
Three-speed mechanism of apple-press, *Marmonier Fils*	France.
Lever differential press, *Marmonier Fils*	France.
Wine and cider press, *David*	France.
Hydraulic press, *Mannequin*	France.
Hydraulic oil-press, *Mannequin*	France.
Combined screw and hydraulic press, *Cassan Fils*	France.
Wine and cider press, *Quillet*	France.
Wine and cider hand-press, *Quillet*	France.
Toggle-press, *Samain*	France.
Toggle-press, caisson, tampon, and barrel, *Samain*	France.
Trussing-press, *Guilhem*	France.
Forage press, *Guitton*	France.
Ration press, *Guitton*	France.

Press Drill. A drilling machine largely used in gun and sewing machine work.

In the form shown in Fig. 2045, it runs by belts, avoiding the noise of gears. The sizes of spindle pulleys give a variety of speeds for drilling holes from 1-16″ to ¾″ diameter, and the driving cross pulley has 4 speeds. The work is elevated by vertical motion of the table; lever and treadle arrangements being provided for the purpose.

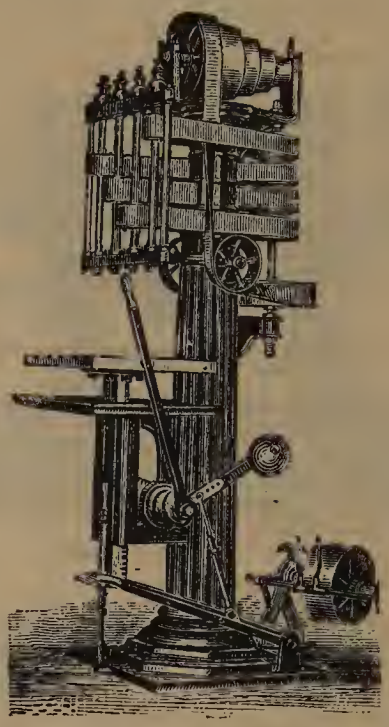
Pressed Fuel. See FUEL, ARTIFICIAL, "*Mech. Dict.*," *et supra.*

Loiseau; Newton; Anthracite Fuel Co.; Prince's Report in Group I., "*Centennial Reports*," vol. iii., p. 54.

Loiseau . . . . . "*Van Nostrand's Mag.*," xxiii. 41.

Pressed Glass. (*Glass.*) Glass made in a mold by pressure. This may be solid or with knobs, insulators, etc.; or hollow, as with bottles, which are blown and pressed in a mold; and some other things pressed hollow without blowing.

Fig. 2045.



Press Drill.

Iron molds are generally used, but wooden molds are very common in France.

Press'ing I'ron. A SMOOTHING IRON; FLAT IRON, etc.

See FLUTING IRON; GAUFFERING; IRONING MACHINE; SMOOTHING IRON, etc. See also LAUNDRY.

Pres'sure Bar. A device in a planing machine for holding down lumber to be planed.

The long suits of the Woodworth and the Woodbury Patents were upon pressure bars and pressure rollers.

Horton's. . . . . "*Iron Age*," xvii., April 20, p. 11.

The PRESSURE BLOCK or PRESSURE ROLLER have the same duty.

Pres'sure Gage. An instrument used for indicating the pressure of an elastic material; steam, air, gas, etc. See various forms in Figs. 3939–3942, pp. 1736, 1737, *Mech. Dict.*;" STEAM GAGE, Figs. 5674–5677, p. 2345, *Ibid.* Also GAGES, Figs. 5678–5683, pp. 2345, 2346, *Ibid.*

1. The gas pressure and vacuum gage is shown in Fig. 2046. It has a cast-iron case containing two brass tubes or wells; in one of them is a float, to which is attached a small cord passing over a pulley. this carries a pointer over the range of a dial. Such instruments are generally used near the hydraulic main, or in the exhauster room to indicate the pressure at any time. The pressure gage shows from 0″ to 18″ pressure, and the pressure and vacuum gage ranges from 9″ pressure to 9″ vacuum.

See also *A*, Fig. 3939, p. 1786, "*Mech. Dict.*"

2. An instrument used to detect the pressure in a cannon or fire-arm at the instant of explosion of the charge. See also CRUSHER GAGE; PIEZOMETER.

Fig. 2047 shows Rodman's pressure gage as adapted to the Springfield service gun and cartridge.

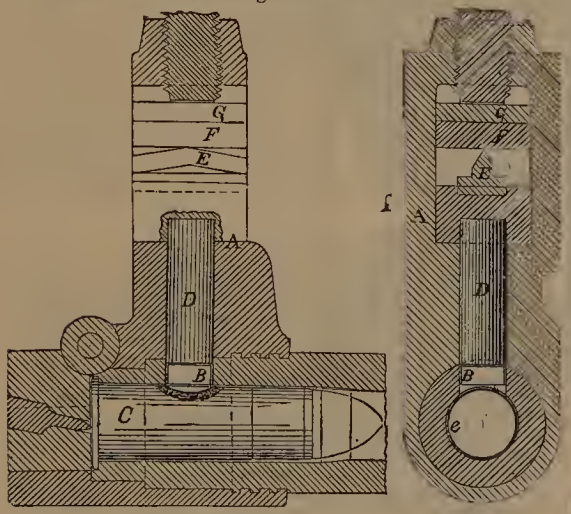
"The usual breech arrangement of the gun should have added a projecting frame, *A*, specially made for strength and accommodation of the piston *D*, knife *E*, and copper and steel plates *F* and *G*. A gas check *B* is used to prevent the escape of gas at the piston *D*. The cartridge *C* has a hole in its side the same size as the piston *D* (area 1-10 square inch); the edges of the hole in case are required to be made thin by a special operation, and lay snugly to the side of chamber to

Fig. 2046.

Gas Pressure and Vacuum Gage.

prevent the escape of gas. No reliable results can be obtained if the gas is allowed to escape at this point. A slip of paper is inserted into the case to prevent the powder from falling out; the charge is ignited in the usual manner; the gas forces the piston *D* against the knife *E* into the copper plate *F*, making a cut; the knife and copper are removed to a weighing machine, and a corresponding cut of equal length is made in the same copper. A record of 50 shots gave a maximum of 14,000 lbs., and a minimum of 12,000 lbs. Mean 13,000 lbs. per square inch for the service cartridge — 70 grains powder, 450 grains ball."

Fig. 2047.



Rodman's Pressure Gun.

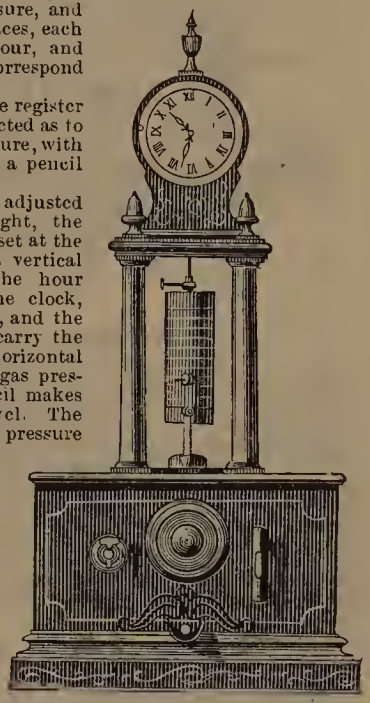
Apparatus, *Bouvet* . . * "*Eng. & Min. Jour.*," xxv. 129.
Pictet . . . . . * "*Eng. & Min. Jour.*," xxv. 112.
Gage, *Allan*, Br. . . . * "*Engineer*," xliv. 193.
Allen, Engl. . . . . * "*Scientific Amer.*," xxxvii. 258.
Gage (theory), *Bourden* * "*Scientific American Sup.*," 1105.
Gage, *Shaw* . . . . * "*Mech. Dict.*," Fig. 3943, p. 1787.
Gage, steam . . . . * "*Iron Age*," xix., March 1, p. 11.
Gage, *Snyder* . . . . * "*Scientific American*," xxxvii. 6.
Indicator, electrical.
Shaw . . . . . "*Scientific American*," xlii. 131.
Log . . . . . "*Scientific American Sup.*," 1089.
Reducing valve, *Alley*, Br. * "*Engineer*," xlviii. 104.
For mains, *Barton & West* . . . . . * "*Engineer*," xlviii. 112.
Register . . . . . "*Laboulaye's* "*Dict.*," iv., "*Graphiques.*" Fig. 16.
Regulator, *Giroud* . . "*Iron Age*," xx., Dec 13, p. 7.
Holly . . . . . * "*Scientific American*," xxxix. 95.

Pres'sure Reg'is-ter. An instrument elastic cording the fluctuations of pressure of an for re- body: steam, air, gas, etc. See RECORDING STEAM GAGE, Fig. 5083, p. 2346, "*Mech. Dict.*"

The gas pressure and vacuum register is an instrument used for recording the variations of pressure on street mains, at works, office, or any desired point of distribution, and is made with any required range of from 1″ to 6″ for 1″ working pressure, but is generally made for 5″ pressure to give a range of 12″.

Attached to the clock is a vertical barrel which makes 1 revolution every 24 hours; around this is a printed card divided horizontally, by lines, into 50 spaces, each representing 1-10″ pressure, and vertically into 24 spaces, each representing one hour, and so marked as to correspond with the clock.

Fig. 2048.



Pressure and Vacuum Register.

In the body of the register is a float, so constructed as to rise 12″ for 5″ pressure, with brass rod carrying a pencil holder.

When the water is adjusted to the proper height, the point of the pencil set at the zero line, and to a vertical line representing the hour corresponding to the clock, the gas is turned on, and the float will rise and carry the pencil up to the horizontal line indicating the gas pressure when the pencil makes its mark on the barrel. The tracing is thus a pressure and time line.

The pressure and vacuum register, Fig. 2048, is governed by the same principles as the pressure register, and is designed to keep record also of the degree of vacuum in the exhauster.

The card is divided the same, vertically, but in the horizontal divisions it differs, as it is divided into sixty spaces each representing 1-10″ pressure, the zero line being the twentieth from bottom, the space below the zero line representing 2″ vacuum, and the space above 4″ pressure.

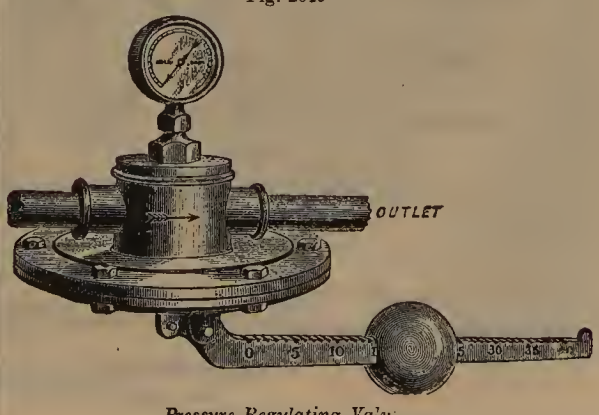
In adjusting the water line in this instrument, the point of the pencil is brought to zero line and to vertical line, corresponding to the hour of day shown by the clock. Gas then being turned on, any change of pressure or vacuum will be duly recorded, the cards to be changed daily and filed away as with Pressure Register.

See also METER PROVER, *supra*.

Pres'sure Reg'u-la'ting Valve. An apparatus to obtain a constant pressure of steam or air from a supply reservoir, wherein the pressure varies.

The form of apparatus shown in Figs. 2049, 2050, is specially intended for the abstraction of steam for heating purposes under pressure in a boiler much in excess of what is

Fig. 2049

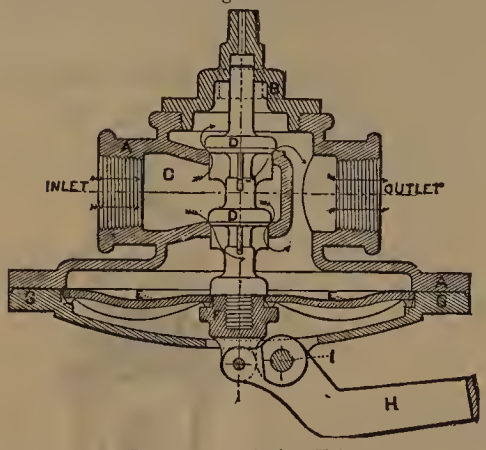


Pressure Regulating Valve.

demanded for the heating. The heating purposes referred to are for vacuum pans, heating apartments, drying rooms, bleacheries, paper machines, etc.

Fig. 2049 is an exterior view of the apparatus with a low pressure gage attached, and a lever beneath, with a weight

Fig. 2050.



Pressure Regulating Valve.

by which the pressure is regulated. The sectional view, Fig. 2050, shows the casing *A* with a screw-cap *B*. *C* is the inlet-chamber, and *D* is a balanced puppet valve, the raising of which allows steam to flow upwardly and downwardly into the main chamber of the valve, and thence to the outlet. The degree of opening of the valve is regulated by a large, flexible, thin, sheet-brass diaphragm *E*, clamped by the bottom-piece *G* to the base of the case *A*. The downward steam pressure on the diaphragm is opposed by the upward pressure of the weight on lever *H*, and this is so adjusted as to open the valve to such a degree as to admit the passage of such an amount of steam as may keep the pressure in the apparatus for which it is provided, at a given pressure, and consequent heat.

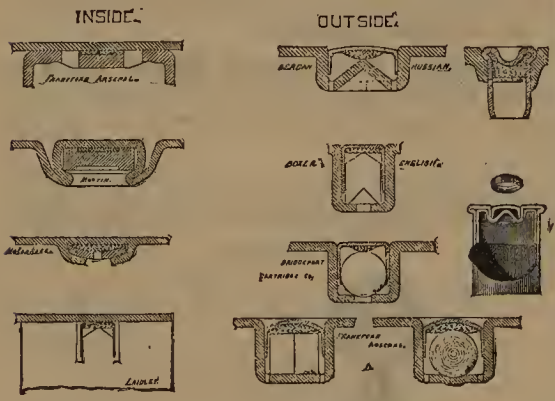
See: * "*Iron Age*" . . . . . xxv., March 4, p. 9.
* "*Manuf. & Builder*" . . xi. 241.

Pri'ma-ry Coil. (*Electricity.*) The inner coil of the helix.

Pri'ma-ry Cur'rent. (*Electricity.*) That which passes through the primary coil.

Pri'mer. An exploder attached to a fire arm, ordnance, or cartridge. See FRICTION PRIMER; PRIMER, "*Mech. Dict.*"

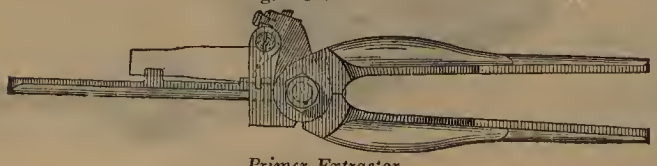
Fig. 2051.



Primers.

Fig. 2051 shows a variety; some adapted to the inside, and some to the outside of the head of the cartridge.

Fig. 2052.



Primer Extractor.

French friction primers, land artillery. *Laboulaye's "Dictionnaire," "Artifices de Guerre,"* Fig. 166.

French friction primers, marine, *Ibid., b.*

Pri'mer Ex-tract'or. A tool used to withdraw the spent primer capsule, in reloading metallic shells. See RELOADING TOOLS.

Pri'ming Ma-chine'. A machine to put the fulminate in the cap, which is to be attached to the cartridge shell.

One which places the fulminate in percussion caps.

Print'ing Press. Perfecting presses, *i. e.*, those which print both sides of the sheet at a single passage through the machine, usually work upon a continuous web of paper, the continuous sheet passing through the machine, passing between a type and impression cylinder, by which one side is printed and then between a similar pair of cylinders which print the reverse side; thence passing to the cutter which severs the sheets and thence to the folder.

Perfecting presses usually print from stereotype plates, some running as high as from 12,000 to 50,000 perfect papers per hour. The following are shown in the "*Mech. Dict.*," at the pages noted: —

Hoe & Tucker, Perfecting Web Press, Fig. 3640, p. 1666.

Walter Press, London "Times," Fig. 3641, p. 1667.

Bullock Press, Web Perfecting, Fig. 3642, p. 1667.

Victory Printing and Folding Machine, Plate XLIII., p. 1798.

Hoe's Web Perfecting Printing Machine, Fig. 7137, p. 2751.

Augsburg (German) Web Perfecting Press, Fig. 7138, p. 2752.

The preparing of stereotype plates involves a loss of at least 20 minutes after the forms have been set up by the compositor. The type revolving newspaper perfecting press of Hoe & Co., shown in Plate XXXIX., is made to print from type forms, from a roll of paper, at a rate of 12,000 per hour, and fold and deliver the perfected papers from one set of forms.

The type which is set up in the usual way in the composing room is placed in curved type beds, known as *turtles*, similer to those used in the multiple cylinder type-revolving machines, shown at page 670, and Plate XI., "*Mech. Dict.*" These beds, which contain the forms for the pages (say four) of the newspaper, are placed upon a large central cylinder around which at intervals are four plain cylinders with blankets on them and which take the impression.

The paper, which is in a large roll say 30″ or more in diameter, is placed at the end of the machine, and the sheet — the "*web*" — passing through rollers and tapes is conducted around the first of the impression cylinders. As the central cylinder revolves against it the impression of the whole four pages is taken upon the paper. The sheet is then carried over a roller and introduced upon the second impression cylinder when the four pages are again printed upon it. The web of paper is then carried through rollers underneath the large type cylinder and by an arrangement of bars and rollers turned completely over. From the turning apparatus it is conveyed to the third impression cylinder, and again receives, opposite the side printed by the first impression cylinder, an imprint of the four pages of the paper. Again the paper is carried around a roller and introduced around the fourth impression cylinder, against which is printed in its turn, on the back of the impression made by the second cylinder, another of the whole four pages.

It will thus be seen that in one revolution of the large type cylinder four distinct papers or impressions have been printed on the web of paper.

The portion of the central cylinder which is not occupied by the type is used as a distributing surface for ink which is placed in fountains and conveyed by an arrangement of composition rollers to this distributing surface, which in turn carries it to the rollers inking the forms of type, and which are placed between each of the impression cylinders.

The paper, which now contains upon it four complete printed newspapers, is brought by tapes to two

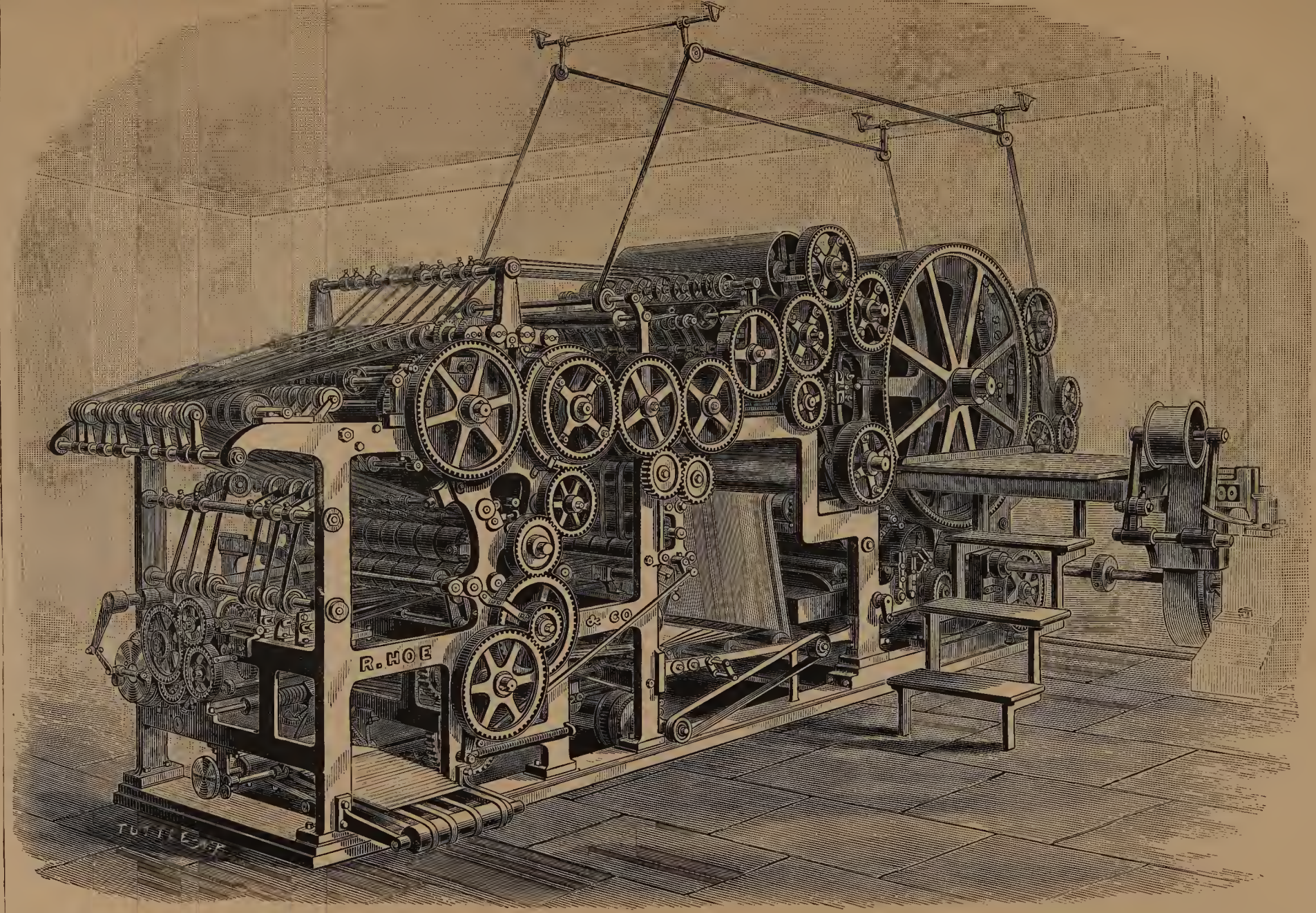


PLATE XXXIX HOE'S TYPE REVOLVING NEWSPAPER PERFECTING PRESS *See page* 720.

cylinders placed one upon the other. In one of these is a knife with a blade like a saw which at each revolution of the cylinders shoots out and cuts the paper apart.

The papers then, carried between tapes, enter the folding apparatus. This consists first of cylinders provided with grippers or fingers which seize the paper as fast as presented by the tapes. Within the circumference of these cylinders is a revolving blade so placed that its edge strikes the paper in the center margin between the pages driving it down between two rollers through which it is carried and given the first fold. As soon as the sheet is clear of the rollers, a knife placed upon an arm strikes it across the center of the page and drives it again between two other rollers which give it the second fold, and this operation is repeated until the required number of folds have been made, when the paper is deposited on a traveling belt or platform, which receives the papers and counts them in 10's, 20's, 50's, or 100's as required. If desired, the apparatus for giving last folds can be disconnected and the papers delivered folded twice for the carrier, the extra folds being intended for the mails.

Besides the foreman of the room only one attendant is required for the press, whose duty it is to watch the roll of paper, and a boy to remove the papers as delivered.

The series of patents to J. T. Hawkins (Campbell Printing Press Co.), Nos. 257,576-257,581, constitute the foundation of the system of printing presses now being built by the company.

The first of the series stated concerns the gearing of the cylinders continuously to the beds, insuring uniformity of surface velocity, and permitting the use of very small cylinders, so small as to make more than one revolution in each direction during the passage of the form or stone; this machine being specially for lithographic printing, and working but one side of the paper.

The next in series adds the perfecting feature, which adapts it to newspaper printing; working the sheet on both sides, taking the sheet, tail first, on the reverse revolution.

The third in series shows a delivery of the sheet, adapted to general book and job printing, where various-sized sheets are printed on the same machine on both sides, avoiding contact of the last-printed side with tapes or fly-fingers.

The fourth adapts the system to the double-cylinder form of press so much used on evening papers of moderate circulation, the speed of which presses is ordinarily limited by the methods employed to impart motion to and overcome the momentum of the bed, the cylinders revolving in one direction only. The equilibrating principle is the peculiar feature of this one of the series.

In the fifth in series the whole system, including the equilibrating principle, is adapted to a perfecting web press working from the origiual type forms.

The perfecting press of Cottrell & Babcock works sheets. Its foundation is the drum cylinder press, embracing the air-spring and governor.

The rotary attachment consists of two cylinders, — one for curved stereotype plates of the matter to be printed, the other to give the impression. These cylinders are supplied with a feed-board, and revolve in harmony by the instrumentality of the usual gear-wheel attachment, making two revolutions while the drum cylinder of the main press makes one, and yielding the sheet, when printed on one side from the curved stereotype plates, to a supplementary set of grippers on the drum cylinder, in perfect register, when it passes to the flat form on the bed of the main press, and is printed on the other side and piled in the usual manner.

The type cylinder is supplied with an ordinary distributing apparatus for four-form rollers; and as it revolves twice before printing, the form is necessarily rolled twice also, with a fresh supply of distributed ink each time.

At each alternate revolution of the impression cylinder the impression is thrown off by a simple mechanical device, by which means the complete rotary attachment (as it gives the impression on its second revolution) works in harmony with the drum cylinder of the main press.

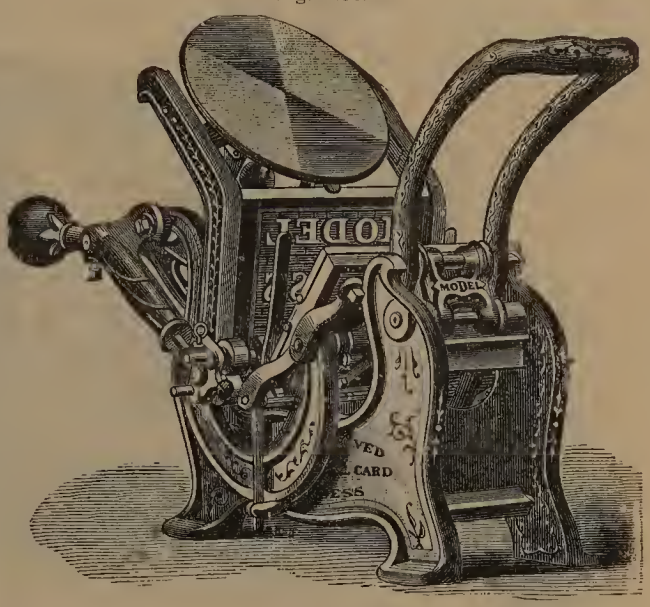
Chromo printing, *Greenwood & Kritch*, Br. As many forms are prepared as there are colors in the picture or lettering, and these occupy the bed in succession; the edition being run through in one color, the form is changed, the next color worked, and so on. It has an upright gang of three inking rollers. The platen vibrates in an arc, then moves horizontally to make the impression.

The small-size hand-presses have arrived at great rapidity and quality of work.

The Daughaday self-inking press is shown in Fig. 2053. The impression is produced by simply pressing upon the handle which acts upon the double toggle connected directly with the platen. The chase is held in place by a screw latch shown at top.

The curved arm shown at the side of the press operates the self-inking apparatus. A similar curved arm is on the other side, which insures an equal motion, free from side strain. The ink-roller journals are hinged, and the rollers are kept in contact with the type and distribution-disk by a simple spiral spring inside the arms, so that they not only adapt themselves to the size or irregularity of the type form, but to the curving track, as they approach the ink-disk. The ink-roller arms are very accurately balanced, and pivoted at the rear of the press, as shown, so that there can be no irregular motion. The ink-disk revolves slightly, after the rollers leave it, with each impression, giving a fresh surface for distribution of the ink. At the instant of taking the impression, the inking-rollers remain stationary on the disk, after which the surplus power is used in inking the form for a new impression. There is a *dwell* on the face of the type during the impression.

Fig. 2053.



"*Model*" *Hand-Press.*

On stuffs. History in vol. ii., *Laboulaye's* "*Dict. des Arts et Manufactures*," article "*Impression sur Étoffes.*"

Elaborate description in 52 pages, containing machines, processes, dyes, etc.

Ceramics. See TRANSFER PRINTING; BAT PRINTING, "*Mech. Dict.*"

Photogr. Direct ink printing from glass negatives. See "*Scientific American Sup.*," 2080.

Color printing, *Prang*, "*Scientific American*," xliii. 40.

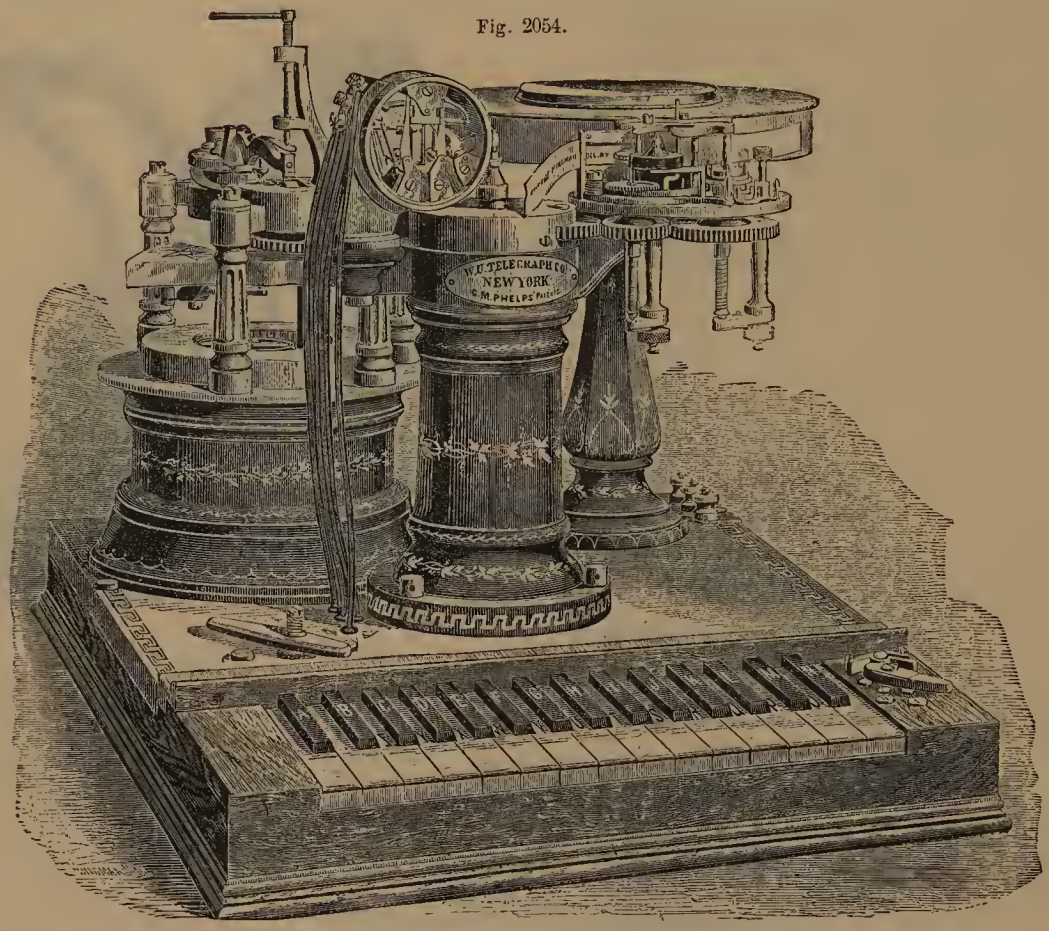
Improvements during the century, *Faxon*, "*Centennial Reports*," Group XIII., pp. 20-22.

Printing rollers for wall paper * "*Sc. Amer.*," xxxvii. 226.
Print-washing machines . . * "*Sc. Amer. Sup.*," 1543.

Ink factory, *Mathers* . * "*Scientific American*," xlii. 223.
Perfecting, *Alauzet*, Fr. * "*Scientific American Sup.*," 2475.
Campbell . . . . * "*Scientific American*," xxxv. 47.
Derriey . . . . . * "*Scientific American Sup.*," 2617.
"Victory," *Duncan & Wilson*, Engl. . . . * "*Scientific American Sup.*," 1199.
Web perfecting, *Hoe* . * "*Engineering*," xxii. 412.
Web, *Hoe* . . . . . * "*Engineer*," xliii. 215, 218.
Perfecting, *Hoe* . . . * "*Min. & Sc. Press*," xxxiv. 113.
* "*Scientific American Sup.*," 719.
Web, *Ingram*, Engl. . * "*Scientific Amer.*," xxxvii. 303
Ingram, Br. . . . . * "*Scientific American*," xxxix. 291.
* "*Scientific Amer.*," xxxvii. 303.
* "*Illus. Lon. News*," Oct. 6, 1877.
Web, *Ingram*, Br. . . * "*Engineer*," xliv. 239.
* "*L'Exposition de Paris*," 1878, p. 224.
Manufacture, *Cottrell & Babcock* . . . . . * "*Scientific American*," xlii. 191.
Hand, *Daughaday* . . "*Scientific American Sup.*," 528.
* "*Engineer*," xli. 412.
"Liberty," *Degener* . * "*Scientific American Sup.*," 518.
"Excelsior" . . . . * "*Iron Age*," xviii., Nov. 16, p. 5.
Walter . . . . . "*N. Y. Tribune*," May 24, 1876.
* "*Scientific American Sup.*," 374.
Water colors, mechanical, *Husnik* . . . . * "*Scientific American Sup.*," 1008.

Print'ing Tel'e-graph. One which records the message in readable form. The term is gen-

Fig. 2054.



Phelps' Electro-motor Printing Telegraph.

erally restricted to those which use the common alphabet.

The *Vail*, *Bain*, *House*, *Hughes*, * *Phelps*, * *Anders*, * *Edison*, * *Van Hœvenberg* instruments are described on pp. 1800–1802, "*Mech. Dict.*" See, also, PRIVATE-LINE TELEGRAPH, *infra*.

The automatic printing telegraph of *Edison*, *Phelps*, * *Meyer* are described in *Lines'* "*Report of Vienna* (1873) *Exposition*," p. 37 *et seq.*, vol. ii., Sec. I.

The autographic telegraphic is in a sense a printer. *Meyer's* * Fig. 130, p. 56, *supra*; *Caselli's*, p. 191, "*Mech. Dict.*," * *D'Arlincourt*, *Lines'* Rept., above cited, p. 40; *Sawyer's*, * "*Scientific American Sup.*," 302.

Gray's automatic printer (Western Electric Manufacturing Co.) is largely used on private stock-board and municipal lines.

The sending operator prints out his message in plain letters at the distant end of the line, whether the receiving operator is at the instrument or not. The message is also printed by the transmitting instrument. This printer is self-starting, self-stopping, and self-correcting. Any person who knows how to spell and to read can use it.

In the Phelps electro-motor printing telegraph, Fig. 2054, the type-wheel and printing mechanism is operated by a rotary electro-magnetic engine which is set in action by a local battery.

The apparatus consists of the following parts: —

The transmitting apparatus, consisting of the key-board and circuit-closing devices.

The receiving and printing mechanism.

The automatic unison mechanism.

The electro-motor and speed governor.

"The principle upon which the instrument acts may be described as a combination of the synchronous and step-by-step movement. Like the Hughes apparatus, the transmitting apparatus and the type-wheel of the receiving instrument are caused to revolve synchronously under control of a governor, and each separate letter is printed by a single pulsation of the electric current of a determinate and uniform length, transmitted at a determinate time, but, unlike the Hughes apparatus, the motion of the type-wheel is arrested while each letter is being printed, and is automatically released the instant the impression has been effected. Thus a speed of revolution may be given to the type-wheel in this instrument far greater than it would be possible to attain by means of a step-by-step movement, while at the same time letters which happen to come in direct sequence upon the key-board may be printed from during the same revolution." — "*Journal of the Telegraph.*"

The key-board is seen in front, its black and white keys being lettered, and behind it rises the hollow column of the transmitter, within which is a circular range of 28 slide rods corresponding to the keys of the board. It also contains the mechanism by which the circuit closer is actuated. In the center of the column is a vertical shaft which is rotated 240 times per minute by means of the electro-motor shown on the left, the speed being controlled by a governor. The circuit closing mechanism admits of either the single current or the double current system of transmission being employed by merely changing the connections. The printing mechanism is shown upon the right, and the tape drum at the rear.

The details of the ingenious and complex apparatus are to be found in the "*Journal of the Telegraph*," *Prescott's* "*Electricity and Electric Telegraph*," and reproduction of the same, * "*Scientific American Sup.*," 831, 882.

Herring	* "*Telegraphic Journal*," vi. 493.
	* "*Scientific American Sup.*," 2611.
Higgins	* "*Telegraphic Journal*," vi. 131.
Electro-motor, *Phelps* .	* "*Telegraphic Journal*," v. 74.
	* "*Sc. American Sup.*," 831, 882.

Prism. The subject is considered under PRISM, pp. 1802–1804, "*Mech. Dict.*," and several forms are shown in Fig. 3963, p. 1803.

The following are forms used in microscopy: —

Amici's.	Right angle.
Nachet's.	Double image.
Nichol's.	Equilateral.
Diatom.	

Pris-mat'ic Glass. A glass prism used for showing the solar spectrum.

Pris-mat'ic Pow'der. Large grained gunpowder for slow burning in heavy ordnance. Also known as POUDRE BRUTALE, PEBBLE POWDER, PELLET POWDER.

Prismatic powder is molded under pressure into hexagonal prismatic form and pierced with 7 small holes made at the time of molding by tapered spindles. See Machine, Plate III. accompanying Col. Laidley's report, Appendix K., "*Ordnance Report*," 1877, * p. 448, and pp. 523, 525, with Figs. 16½ and 21, Appendix L.

The idea originated, it appears, with Col. Rodman about 1861, but the only machine for the purpose is that of Prof. Vichnegradski, copied into Prussia and Holland.

The prisms are 1″ thick, weigh 600 grains and have 7 holes, each .015″ diameter. Density, 1.65 to 1.75.

Of allied shapes are some of those, sphero-hexagonal, cubical, polyhedral, etc., the subject of trials and a report: "*Ordnance Report*," 1879, Appendix II, 7, * p. 85; and Appendix I., p. 124, and Plate VIII.

The manufacture of hexagonal powder at Du Pont's mill is described on pp. 124, 125, and Plate IX., "*Ordnance Report*," 1879, Appendix I.

"*Engineer*" . . Sept. 16, 1870; March 17, 1876, p. 185.

Prism Bat'te-ry. A form of Leclanché battery in which the usual porous cup is dispensed with, and a pair of compressed prisms containing all the materials formerly used in the porous cup are substituted for it.

These prisms are placed upon opposite sides of the carbon plate, and are kept in place by rubber bands. See Fig. 1574, p. 538, *supra*.

The negative pole is a pencil of amalgamated zinc, and the two poles are suspended from the cover in a solution of sal-ammoniac.

Pris'moid-al Rail'way. A wooden or iron beam is supported on posts, the cars are mounted saddle-fashion; the engine grips the rail. Used in South Africa.

Pris'on. *Cook & Heath's* "Perfected systems of Prisons," is the subject of a brochure published at Memphis, Tenn. Patents, 1874, 1875.

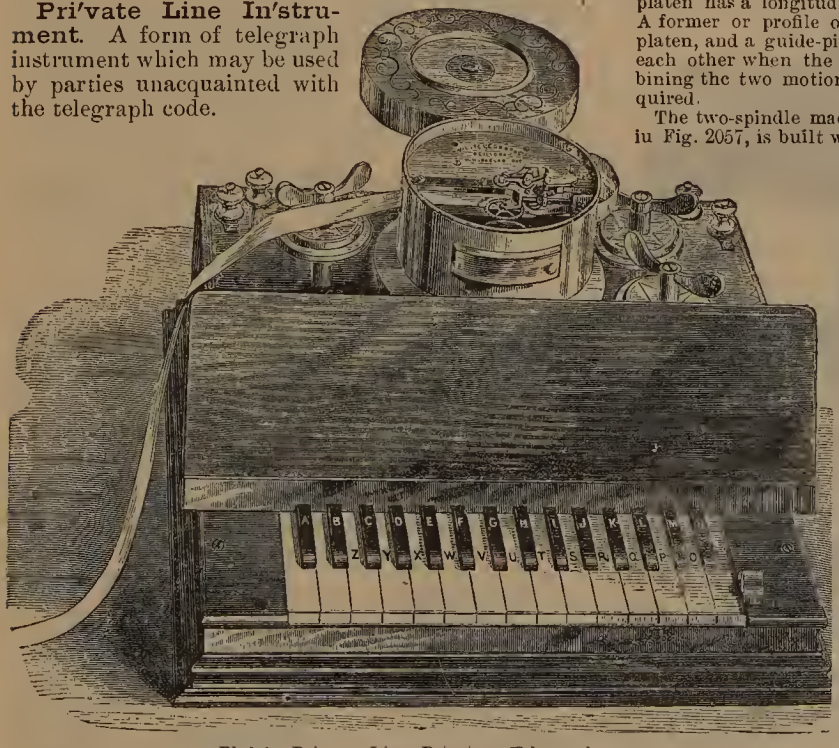
The points of value are the use of cast-iron for windows and doors and lining of cells. An outer wall being of brick or stone.

Between the walls is a mass of dry sand which issues into the cell when the wall is punctured.

The running of the sand actuates an alarm and rouses the guard.

Fig. 2055.

Pri'vate Line In'strument. A form of telegraph instrument which may be used by parties unacquainted with the telegraph code.



Phelp's Private Line Printing Telegraph.

Such a one is shown in the *Auders* instrument, Fig. 3960, p. 1802, "*Mech. Dict.*"

The dial telegraph, Fig. 806, p. 254, *supra*, is another form.

The machine of Phelps, shown in Fig. 2055, has the sending and receiving apparatus on the same stand; the former having a finger-board and the latter an automatic printer.

Pro'bang. An instrument to remove an obstruction from a passage. Several forms are shown in Fig. 3965, p. 1804, "*Mech. Dict.*"

Fig. 2056 shows a bristle probang for removing foreign substances from the throat and air passages.

Fig. 2056.

Probangs and Probe.

A contrivance for the same purpose, in which the disk is brought to a transverse position after the object is passed.

A porcelain bullet probe on a flexible staff.

Pro'cess Mil'ling. A term which, like *new process milling*, refers to the modes of high grinding, or of treating the middlings. See CYLINDER MILL; HIGH-GRINDING; MIDDLINGS; ROLLER MILL, and references *passim*.

Pro-du'cer. (*Metallurgy.*) The fuel chamber and gas producer of a Siemens' or similar furnace. See GAS PRODUCER; GAS GENERATING FURNACE; PONSARD FURNACE; SIEMENS' FURNACE, and references *passim*.

Pro-fil'ing Ma-chine'. The machine is shown in Fig. 3969, p. 1806, "*Mech. Dict.*" The purpose is there described. It is used for milling around the inside and outside edge of irregular shapes, and for surfacing and inside milling.

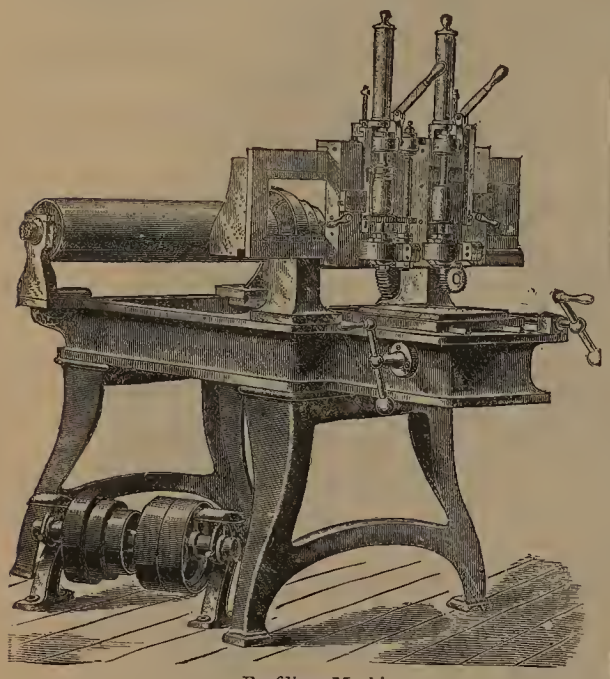
The spindle carriage has a side motion across the bed. The platen has a longitudinal motion under the cross-head. A former or profile of the shape required fixed to the platen, and a guide-pin fixed to the carriage, act upon each other when the machine is operated, and by combining the two motions give the cutter any direction required.

The two-spindle machine of Pratt & Whitney, shown in Fig. 2057, is built with Parkhurst's device for cutting formers without reversing the fixtures. To produce the forming pattern, the model piece is secured in the place and position afterward occupied by the work to be machined, and the piece to be cut for the forming pattern is placed in the position it will permanently retain. The guide-pin is put in the spindle which usually carries the cutter, and follows the outline of the model piece, while the cutter, in the spindle, which afterward holds the guide-pin, cuts the forming pattern in the exact position it will retain in use. After disconnecting the gearing upon the spindles, reversing the relative positions of the guide-pin and cutter, and smoothing the edge of the forming pattern (if this be necessary), the machine is ready for work. The gearing for moving the table and cross-slide is adjustable by means of double gears, set to prevent back-lash by two independent adjusting screws, and also by a double rack adjusted in the same manner.

The automatic edging machine is of a similar character to the

profiling machine, but has an accurate automatic movement for cutting circles of 3″ and less diameter, with their tangents. These machines are made with one, two, or three spindles.

Fig. 2057.

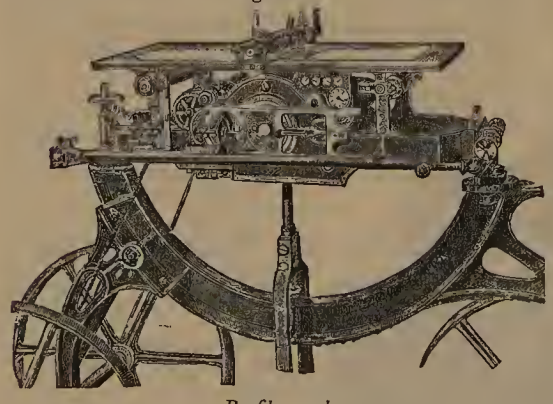


Profiling Machine.

Pro-fil'o-graph. A machine for tracing mechanically the outline of the surface of the ground over which it travels.

It is a small carriage on 4 wheels, and it is designed to make straight lines between stations. When it diverges the angle is taken and recorded on the profile paper. The carriage supports a small table on which is a flat sheet of paper traveling between an unrolling and a rolling drum beneath slits near the ends of the table. The profile is drawn by a pencil held perpendicularly above the table. All the motions of the machine are operated by an endless chain from the rear wheels or axle.

Fig. 2058.



Profilograph.

Underneath the machine hangs a pendulum which maintains a constant vertical position while the machine, and consequently the table, inclines in one direction or the other as it ascends or descends a slope. These angular oscillations are transmitted by proper devices producing reciprocating movements of the paper and the pencil, diverging from the zero which represents a level. The sheet of paper moves positively and the instrument records the distance passed — not the true base of the profile. The scale for the horizontal distance traversed is in the proportion of 1-1500 and the vertical dimensions 1-500.

In operation, each course is a record. A man draws the carriage along from one station to another. The surveyor at each stop notes the length on the distance indicator, draws a vertical line on the profile paper, notes the heights, then repeats the operation. — "*Nature.*"

Pro-jec'tiles. For illustrations and list see p. 1806, "*Mech. Dict.*"

For list of U. S. Patents on harpoons, lances, bomb harpoons, bomb lances, harpoon guns, etc., used in whaling, see HARPOON.

Effects of, Creusol	* "*Engineer*," xlv. 251.
Terre-Noire	*
Whitworth	*
Cammell	*
Rice	* "*Scientific American*," xli. 395.
Winged for life line, *Hunt*	"*Scientific American*," xl. 376.

Pro-jec'tor. A camera with electric, magnesium, or oxyhydrogen light, for throwing an image upon a screen.

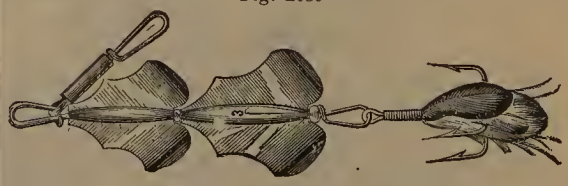
Proof Plane. (*Electricity.*) A metallic disk with insulating handle, employed for removing electricity from one object to another. — *Gordon.*

Pro-pel'ler. 1. A means for propulsion of vessels. A screw on a longitudinal shaft projecting at the stern. See figures, PROPELLER, pp. 1808–1810, "*Mech. Dict.*," and pp. 2070–2073, *Ibid.*

Hand, *Tangen*	* "*Scientific American*," xli. 38.
Adjustable	* "*Scientific American Sup.*," 1471.
Coupling	* *Laboulaye's* "*Dict.*," iv., "*Bateau a Vapeur*," Fig. 3118.
Mechanism	* *Ibid*, i. "*Bateau à Vapeur*," Figs. 23, 24.
Driving and steering	
Mallory	* "*Engineering*," xxvi. 90.
Collis-Browne	* "*Scientific American Sup.*," 426.
Hydraulic, *Curtis*	* "*Scientific Amer.*," xxxviii. 182.
Light draft (Canadian)	"*Scientific American*," xxxv. 255.
Marine	"*Scientific Amer. Sup.*," 190, 191.
Patterns, making	* "*Scientific American Sup.*," 1461.
Screw, *Ben's*, Br.	* "*Engineer*," xliii. 427.
Position of screw, *Brooks*	* "*Scientific American Sup.*," 314.
Screw, *Deane*	* "*Scientific American*," xli. 130.
De Bay	* "*Scientific American Sup.*," 2700.
S. S. "Cora Maria"	* "*Engineer*," l. 133, 136.
Screw, *DeBay*	* "*Scientific American Sup.*," 3975.
Mallory	* "*Engineer*," xlvi. 126.
Rankin	* "*Scientific American Sup.*," 455.
Sheriff's	* "*Boston Journal of Commerce*," Aug. 19, 1882.
Spartal	* "*Scientific American Sup.*," 250.
Shaft, "Thetis"	* "*Scientific American Sup.*," 1281.
Propulsion, steam pump	"*Iron Age*," xix., June 21, p. 15.
Propeller pump	* "*Iron Age*," xviii., Dec. 7, p. 1.
Trial of, *Thorneycroft & Griffith*	"*Scientific American Sup.*," 48.
Variety of forms and orders	* "*Scientific American Sup.*," 61.
Vertical shaft, "Alarm"	* "*Engineering*," xxv. 148.
Vliet	* "*Scientific American*," xlii. 147.
Propelling Vessels	"*Scientific American*," xxxvi. 81.
Wilson	* "*Scientific American Sup.*," 2.
Walker's "*Screw Propulsion.*"	

2. (*Fishing.*) A kind of trolling bait, having oblique wings which cause it to rotate in the water.

Fig. 2059



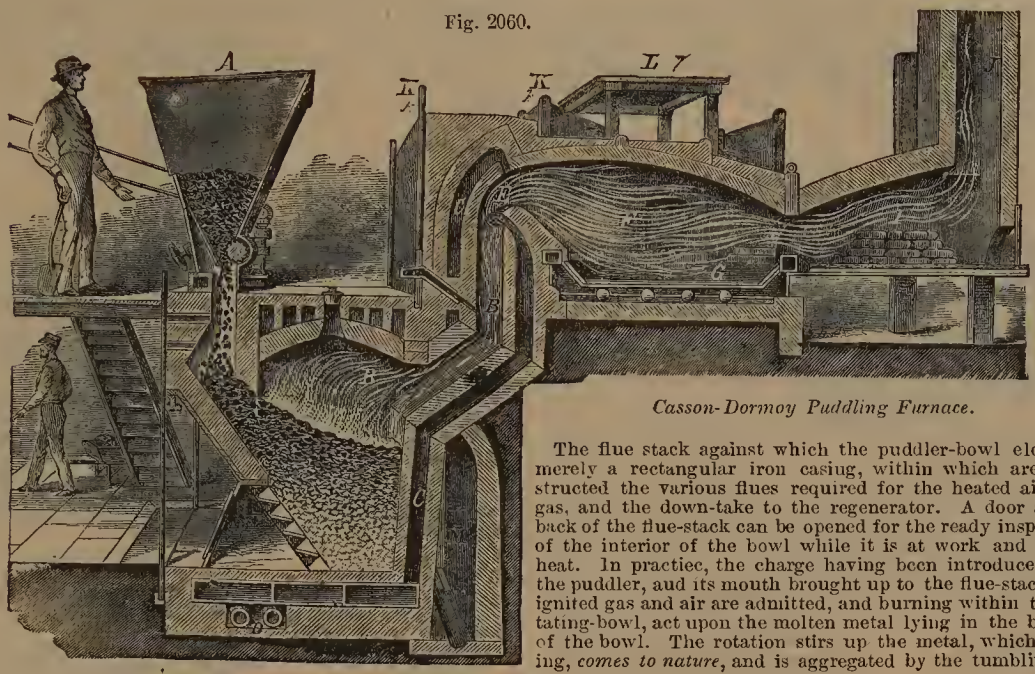
Chapman's Reversible Propeller.

Pro-stat'ic Guide. (*Surgical.*) A slight steel rod upon which is screwed a spiral ribbon; the whole being flexible and used as a guide for a soft rubber through an inflamed prostate gland. — *Dr. Otis.*

Pro-trac'tor. A three-armed circular protractor for plotting position determined by the three point problem, is shown in "*Eng. and Mining Journal*," * xxv. 425.

	* "*Scientific American*," xxxviii. 245, Fig 3.
Cook	* "*Scientific American*," xxxix. 262.
Proportional dividers	* "*Scientific American Sup.*," 2506.

Fig. 2060.



Casson-Dormoy Puddling Furnace.

Pro-vi'so-ry Hoop. A truss hoop. A French form is shown in Fig. 1363, p. 461, *supra*.

Pseu'do-phone. An instrument invented by Dr. S. P. Thompson for producing acoustical illusions and for investigating some of the phenomena connected with bi-aural audition.

It consists of two ear-pieces of tin-plate which are held in their places by adjustable straps, one passing over and the other behind the head. Hinged to each of the ear-pieces is a reflector which is capable of adjustment to any angle and thus the sound is directed into the ear, which, being deprived of the usual conditions by which it is enabled to judge of the the direction, is deceived as to the direction of the source.—* "*Engineering*," xxviii. 195.

Psy'chro-phore. (*Surgical.*) A cold sound. See Fig. 659, p. 209, *supra*.

Pud'dling Fur'nace. One in which pig-iron is subjected to heat, stirring, and chemical treatment in order to refine it. See history and statement, with figures, on pp. 1815–1817, "*Mech. Dict.*"

The processes proceed upon various methods: —

1. The furnaces revolving in a horizontal axis.
2. The pan on vertical axis.
3. Mechanical rabble.

The *Casson-Dormoy* puddling furnace is shown in Fig. 2060 in connection with its adjuncts, the gas producer *B* and the pig-heating chamber *I*.

The gas producer is like the Siemens', but instead of using a regenerator, the incoming air is blown down the sides of the furnace so as to be heated to 800° Fah. when it reaches the bridge at *E*. By means of blast valves a reducing or oxidizing flame is obtained as the condition of the iron may require. The fuel is slack, fed mechanically from a hopper, *A*. The puddling basin *G* is circular and is supported on iron balls in a dish of water, and the contents are first heated in chamber *I*, thence transferred to pan *G* and then boiled, rabbled mechanically, and then balled.

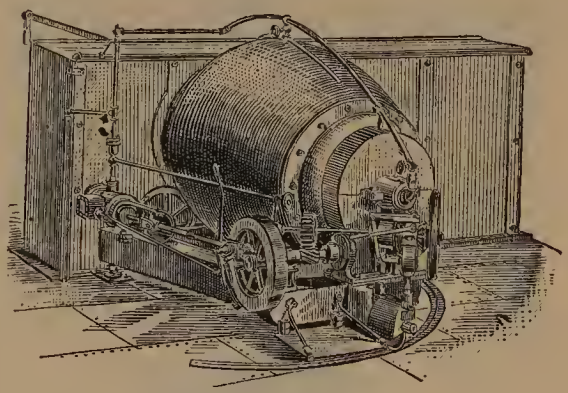
The *Sellers'* puddling furnace is heated from a gas producer. It is flask-shaped. The flame passes in, circulates, and passes out again at the same end by which it entered, on the opposite side of a horizontal partition which divides the opening. The puddler is so placed upon a frame that it can be swung away from the furnace to permit of charging from the front. The parts most exposed to the heat are protected on the outside by water-jackets. The furnace is supported by friction wheels at one end, and on a horizontal pivot at the other.

A small horizontal steam engine is mounted by the side of the furnace, on the same supporting-frame. The whole apparatus is carried by this frame, which is pivoted at the end nearest the open end of the furnace, the pivot-bolt being placed a little on one side and beneath the furnace-mouth.

The engine is so attached that it can be used either to revolve the furnace or to swing the whole machine about the pivot bolt.

The flue stack against which the puddler-bowl closes is merely a rectangular iron casing, within which are constructed the various flues required for the heated air, the gas, and the down-take to the regenerator. A door at the back of the flue-stack can be opened for the ready inspection of the interior of the bowl while it is at work and under heat. In practice, the charge having been introduced into the puddler, and its mouth brought up to the flue-stack, the ignited gas and air are admitted, and burning within the rotating-bowl, act upon the molten metal lying in the bottom of the bowl. The rotation stirs up the metal, which, boiling, *comes to nature*, and is aggregated by the tumbling to-

Fig. 2061.



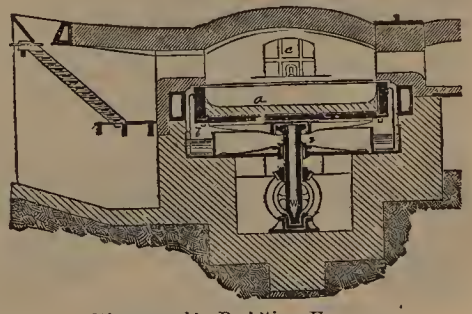
Sellers' Puddling Furnace.

gether of the particles of wrought-iron. After this the surplus cinder can be drawn off through a tap-hole. The bowl being then turned away from the flues, the puddled ball can be readily taken out and carried to the squeezer or hammer.

If the iron be charged as pig, the bowl is not rotated until the metal has melted; but if the charge is drawn melted from a cupola, puddling may begin as soon as the bowl is brought up against the stack and the gases are admitted.

Ehrenwerth's puddling furnace is shown in Fig. 2062 by a longitudinal-vertical section. The horizontal pan *a* is supported on a pivot *w*, to which motion is imparted by bevel gearing. An annular trough, *b*, below the rim of the hearth, serves to form a defense against the flame reaching the gearing and supports. The Siemens' gas furnace is used, as seen

Fig. 2062.



Ehrenwerth's Puddling Furnace.

on the left. The special feature is the rotating hearth, *f* being the fort journal, and *l* the neck journal. The rabbles are introduced through holes in opposite doors; one only, *c*, ap-

pearing in the view. The rabbles move in right lines, and the motion of the hearth brings all its contents under their action. A plate depending from the periphery of the hearth dips into the water: the latter is continually replenished.

Walker & Warren. Diagonal barrel, horizontal axis flame passing through.

Mandslay. Cylinder revolving on diagonal horizontal axis. Reverting flame.

Tooth. Drum on horizontal axis. The piece removable, to allow the ball to be withdrawn at that end.

Tooth & Yates. Drum on vertical axis, with reverting flue.

Danks. Drum on horizontal shaft, revolving between fire-place, and movable flue-piece. "*Mech. Dict.*," p. 1815, Fig. 3992.

Siemens. Furnace on horizontal axis; reverting flue; regenerator. See SIEMENS' FURNACE.

Crampton. Horizontal axis, movable flue-piece, reverting flame.

Clough, Br. A reciprocating rabble passing through a side in the door of the metal chamber. * "*Scientific American*," xxxvi. 15. See also Figs. 3990, 3991, p. 1815, "*Mech. Dict.*"

Godfrey & Howson, Br. A rotary chamber on inclined axis, presenting its open mouth to the charger and to the chimney, and tilting to discharge its contents. * "*Scientific American*," xxxviii. 35.

Pernot. A horizontal pan on vertical axis. On a wheeled carriage moving in or out of battery. See PERNOT FURNACE; OPEN HEARTH FURNACE, *supra.*

See also PONSARD FURNACE, *supra.*

See list of PUDDLERS, MECHANICAL AND REVOLVING, p. 1816, "*Mech. Dict.*"

Furnaces, on	"*Eng. & Min. Jour.*," xxii. 39.
	"*Iron Age*," xxi., May 6, p 24.
List of processes	"*Iron Age*," xviii., Aug. 31, p. 3.
	"*Scientific American*," xxxix. 198.
Furnace, *Abbott*, Engl.	"*Scientific American Sup.*," 2222.
Gas heated, Bethlehem	* "*Iron Age*," xxv., April 1, p. 1.
Oscillating	"*Bulletin du Comité des Forges de France*," No. 112, April 20, 1876.
Caddick	* "*Iron Age*," xix., Feb. 8, p. 5.
Caddick & Maybery, Br.	* "*Engineer*," xliv. 206.
	* "*Am. Man.*," Sept. 5, 1879, p. 9.
	* "*Scientific Amer.*," xxxvii. 271.
Casson-Dormoy	"*Van Nostrand's Mag.*," xv. 51.
	* "*Am. Man.*," Sept. 26, 1879, p. 8.
	* "*Iron Age*," xvii., June 8, p. 1.
	"*Engineering*," xxi. 255.
	* "*Engineer*," xli. 340.
Crampton	"*Iron Age*," xviii., Sept. 7, p. 17.
Danks	* "*Am. Man.*," Sept. 19, 1879, p. 8.
	* "*Mech. Dict.*," Fig. 3992, p. 1815.
Epremworth	* "*Am. Man.*," Sept. 19, 1879, p. 8.
Rocking, *Gedlow*, Br.	"*Iron Age*," xxii., Aug. 15, p. 15.
Furnace, *Godfrey & Howson*, Br.	* "*Iron Age*," xix., Jan. 4, p. 1.
	* "*Am. Man.*," Sept. 19, 1879, p. 8.
	* "*Engineering*," xxiv. 242.
	* "*Eng. & Min. Jour.*," xxv. 272.
	* "*Engineering*," xxii. 85.
	* "*Engineer*," xliv. 247.
Griffith	* "*Am. Man.*," Sept. 26, 1879, p. 8.
Jones	* "*Iron Age*," xvii., May 11, p. 5.
Lukens	* "*Iron Age*," xxiv., Nov. 27, p. 1.
Middleton, Engl.	* "*Iron Age*," xvii., April 13, p. 1.
Middleton	* "*Scientific American Sup.*," 524.
Nair	"*Iron Age*," Aug. 2, p. 39.
Price, Woolwich, Br.	* "*Engineer*," xliv. 316.
	* "*Scientific American Sup.*," 1712.
Reynolds & Thomas	* "*Iron Age*," xviii., Sept. 14, p. 5.
Rotary, *Roe*, Br.	* "*Engineering*," xxiv. 56.
Furnace, *Ryan*	* "*Iron Age*," xviii., July 20, p. 5.
Revolving, *Sellers*	* "*Iron Age*," xvii., March 30, p. 5.
Furnace, *Swindell*	"*Iron Age*," xxii., Nov. 14, p. 15.
Furnace shield	* "*Iron Age*," xxiv., Dec. 25, p. 1.
Puddling, on	"*Iron Age*," xviii., Oct. 5. p. 15.
Art's invention	"*Iron Age*," xix., March 8, p. 9.
Art of, *Howson*	"*Van Nostrand's Mag.*," xxi. 520.
Past and present, *Roberts*	"*Iron Age*," xxv., Feb. 26, p. 9.
Sherman	"*Van Nostrand's Mag.*," xvi. 67.
	"*Iron Age*," xviii., Dec. 7, p. 24.
Mach., paper on, *Howson*	"*Scientific American Sup.*," 1109.
Mechanical	"*Iron Age*," xviii., Aug. 31, p. 3; Sept. 7, p. 17.
	* "*Sc. American Sup.*," 393, 1122.
Griffiths	"*Iron Age*," Aug. 2, p. 28.
Howson	"*Iron Age*," xxiv., Sept. 11, p. 11.
Mackintire, Br.	* "*Engineer*," xli. 271.
Oestland	* "*Eng. & Min. Jour.*," xxvi. 202.
Swedish	* "*Scientific American*," xxxix. 82.
Rotary, *Ehrenworth*	"*Van Nostrand's Mag.*," xiv. 23.
Ehrenworth, Fr.	"*Iron Age*," xvii., Jan. 6, p. 15.
Pernot, Fr.	* "*Iron Age*," xvii., Jan. 13, p. 5.
Danks	"*Iron Age*," xvii., Jan. 13, p. 15.
Puddling, on, *Crampton*, Br.	"*Engineering*," xxii. 61, 81, 85.
Howson, Br.	"*Engineering*," xxiv. 255.
Mechanical stokers, paper on	"*Scientific Amer.*," xxxvii 292.

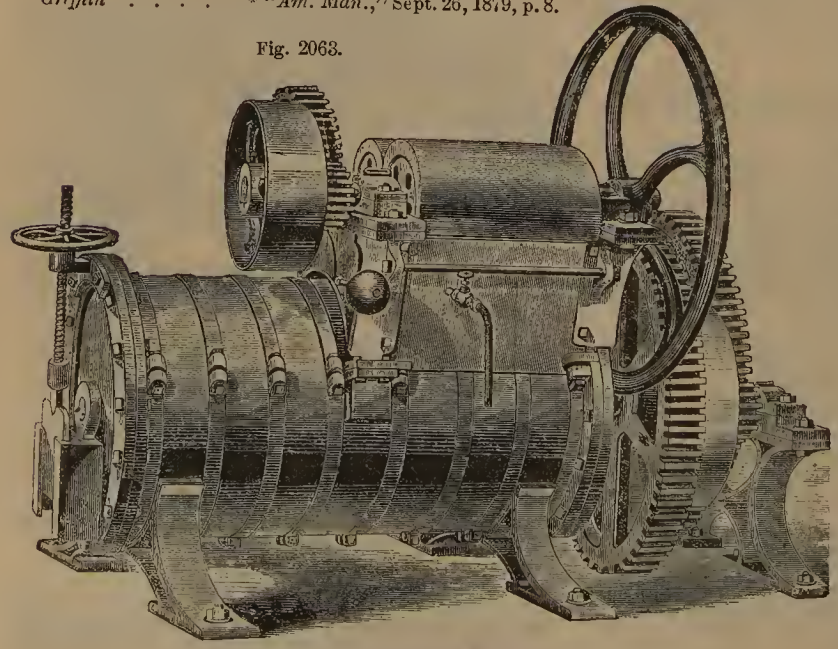
Report by *Holley*, Group I., "*Centennial Reports*," vol. iii., p. 41. Refers to

Danks.	*Schneider & Co.*
Graff, Bennett & Co.	*Sellers.*
Hopkins, Gilkes & Co.	*Crampton.*
Godfrey & Howson.	*Pernot.*

Pug Mill. A mill for working clay into plastic condition for brick-making.

The machine shown in Fig. 2063 is a Philadelphia mill, in which the rear end is elevated 12″. The clay is thrown into a hopper (not shown), passes between rollers which crush the lumps, and thence into the interior of the drum, where it is masticated by blades, and tempered with water introduced through a pipe. The gate at the end governs the discharge.

Fig. 2063.



Carnell's Pug Mill.

Pul'ley. See 22 illustrations, p. 1819, "*Mech. Dict.*"

Made of paper and of raw-hide. — *Cooper*, "*Belting*," xv.

Of leathern disks. — *Cooper* "*Belting*," 77.

Grooved rim pulleys with round belts. — "*Newton's Journal*," 1857, N. S., vi., p. 163.

Leathern covered pulleys. — *Van Nostrand's* "*Eclec. Eng. Mag.*," July, 1869, 604.

Proportions, principles, etc., are carefully considered in *Cooper's* "*Treatise on Belting*," Philadelphia, 1878.

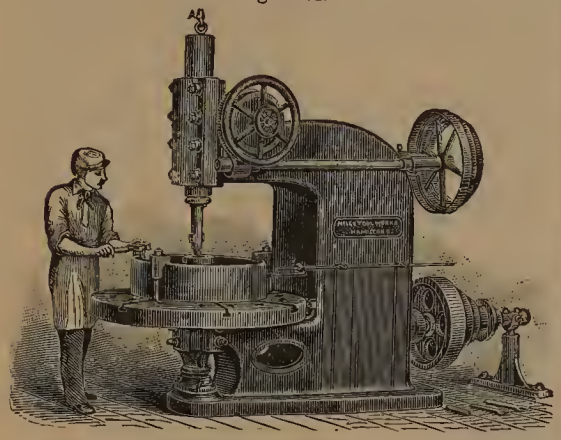
Consult also *Rankine's* "*Rules and Tables.*"

See: Rope-sustaining, *Williams*, Br.
* "*Engineer*," xliv. 446.
Self-stopping, *Wilke.*
* "*Sc. American Sup.*," 315.
Cover, *Sutton.*
* "*Sc. American*," xl. 388.
Riving, *Heer.*
* "*Sc. American*," xxxiv. 291.
Grinding mach., *Thomson, Sterm & Co.*, Br.
* "*Engineering*," xxv. 443
Machine.
"*Sc. American Sup.*," 1617.
Steel rim.
* "*Scientific Amer.*," xl. 89.

Pul'ley Bor'ing Machine'. A special machine tool for boring the shaft-holes of pulleys, but applicable to other similar uses.

The machine, as shown, receives and bores pulleys 52″ diameter; the face plate is revolved by powerful gearing, driven by a cone, with four steps for a 4″ belt. The tool bar is fed automatically and is counterbalanced; it has quick

Fig. 2064.



Pulley Boring Machine. (*Niles' Tool Works.*)

return hand-motion. The feeds are thrown in instantly by friction: they are actuated by belt and worm gearing, rack and pinion (all cut); the feed-belt has three changes of speed, giving feeds of .0648″, .0441″, and .0279″ per revolution of chuck.

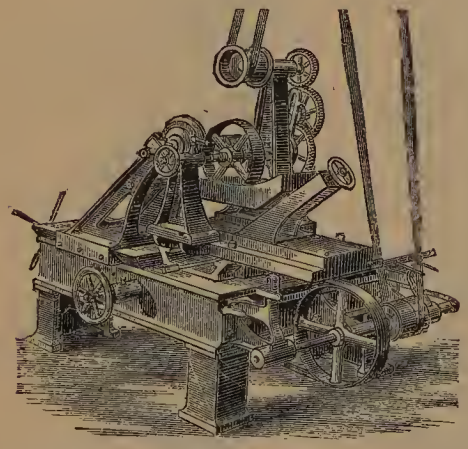
The countershaft is provided with tight and loose pulleys, 24″ diameter, for a belt 4″ wide, and should run 70 revolutions per minute, giving to the chuck-plate speeds as follows: 63, 43, 19, 10 revolutions per minute, thus adapting the machine to bore holes from 1″ to 7½″ diameter. When operating on the latter diameter, the power exerted at the cutting point is 1,800 pounds.

Pul'ley Grind'ing Ma-chine'. Fig. 2065 is a pulley grinding machine made by Thomson, Sterne & Co., of Glasgow, Scotland. It is used for the rims of pulleys, which may be made of the shape required: flat or crowning. The pulleys are cast as thin as may be desired, and the finishing is more thoroughly and rapidly done than by turning.

The machine has an automatic feed, and being self-acting in all its motions, one person can attend to a number of machines.

The different speeds of the work operated on are regulated

Fig. 2065.



Pulley Grinding Machine. (*Thomson, Sterne & Co.*)

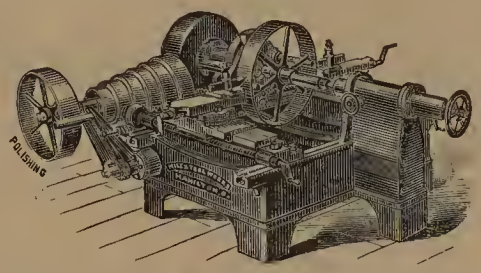
by change-wheels, so as to keep the surface speed somewhat uniform. By a simple arrangement of compound tables worked radially by a worm wheel and connecting rods, the rim of the pulley being ground, can be rounded to any radius.

The pulley being ground runs in a water-trough, which keeps it from heating, and also arrests the dust in grinding. The emery wheel is encased, so that the water and dust carried with it is taken away by the outlet pipe.

Pul'ley Turn'ing Ma-chine'. A special machine tool for turning pulleys, gears, rolls, etc.

It has a large cone pulley, with 6 steps for a belt 4″ wide, and transmits the power through tangent gearing to the main spindle. The carrier plate is of the equalizing type, obviating unequal and lateral strains. On each side of the solid bed-piece are rests which slide in and out on graduated surfaces to suit the diameter of the pulley to be turned;

Fig. 2066.



Pulley Turning Machine. (*Niles' Tool Works.*)

these rests can be set angularly to get any desired degree of *crown;* tools are thus operated on both sides of the machine. The feeds are continuous, can be instantly engaged, disengaged, or changed. The spindle of cone pulley runs at so much higher velocity than the main spindle that its speed is suitable for polishing when the latter is turning; a steel mandrel and a suitable rest are provided for polishing.

* "*Iron Age*" . . . . . xxi., May 30, p. 1.
* "*Scientific American*" . . . . . xxxix. 146.

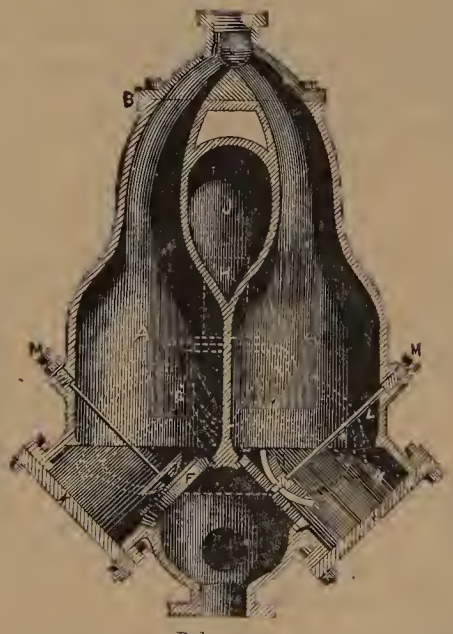
Pul'pit Spec'ta-cles. Spectacles with flat top to the bows to enable a reader to glance over them at an audience.

Pul'sa-tor. A name for the PULSOMETER, which see.

Pul-som'e-ter. A water-raising device, on the principle of the Savery Engine, Fig. 5657, p. 2337, "*Mech. Dict.*"

It consists principally of two bottle-shaped chambers, *A A*, joined together side by side, with tapering necks bent towards each other, to which is attached, by means of a flange

Fig. 2067.



Pulsometer.

joint, *B*, a continuous passage from each cylinder leading to one common upright passage, into which a small ball, *C*, is fitted so as to oscillate with a slight rolling motion between seats formed in the junction.

These chambers also connect by means of openings with the vertical induction passage, *D*, which openings are so formed that the vulcanite valves *E E* and their seats, *F F*, constructed so as to sustain the valves, may be easily inserted.

The delivery passage *H*, which is common to both chambers, is also constructed so that in the openings that communicate with each cylinder are placed valve-seats *G G*, fitted for the reception of the same style of valves as in the induction passage. *I I* are valve-guards to prevent the valves from opening too far.

J represents the vacuum chamber, cast with and between the necks of chambers *A A*, and connects only with the induction passage below the valves *E E*.

K K are flanges covering the openings to the respective chambers, which may be removed for the repair or renewal of valves and seats, when necessary. Vent plugs are inserted into these flanges, for the purpose of drawing off the water to prevent freezing.

L L are rods extending from the valve-guards to the set-screws *M M*, by which the suction seats, valves and guards are tightly pressed to place.

N N are brass socket-headed bolts by which the discharge seats, valves, and guards are drawn down to place.

A small brass air check-valve is screwed into the neck of each chamber *A A*, and one into the vacuum chamber *J*, so that their stems hang downward.

The check-valve in the neck of each chamber, *A A*, allows a small quantity of air to enter above the water, to prevent the steam from agitating it on its first entrance, and thus forms an air piston for preventing condensation.

The check-valve in the vacuum chamber *J*, serves to cushion the ramming action of the water consequent upon the filling of each chamber alternately

See also AQUAMETER, Figs. 105–107, p. 45; HYDROTROPHE, Fig. 1426, p. 486, *supra*; VACUUM STEAM PUMP, "*Mech. Dict.*"

Pulsometer . . . . . * "*Engineer*," xlii. 39.
Hall . . . . . * "*Engineer*," xlvii. 378.
* "*Engineering*," xxii. 56.
* "*Eng. & Min. Jour.*," xxii. 407.
At Normanton quarry . * "*Engineering*," xxiii. 299.
"*Technologiste*," xli. 207.
At work . . . . . * "*Engineering*," xxv. 501.
Hall . . . . . * "*Engineering*," xxviii. 413.
* "*Manufact. & Builder*," xii. 208.
Factory . . . . . * "*Scientific American*," xliii. 63.
Poillon . . . . . * "*Technologiste*," xli. 736.

Pul'ver-i-zer. A word of very general application: —

For *soil*. See HARROW; DISK HARROW; ROLLER; CLOD CRUSHER, etc.

For *stone*. See STONE CRUSHER; STONE BREAKER; DISINTEGRATOR; ORE CRUSHER; ORE MILL; STAMPING MILL; CHILIAN MILL, etc.

For *grain*. See GRINDING MILL; CORN CRACKER; CORN MILL; OAT MILL, etc. See list under MILLS.

For *cement*, etc. See MORTAR MILL; CEMENT MILL; FERTILIZER MILL; PAINT MILL, etc.

Considered structurally, see the following heads, *supra*: —

		Figure.	Page.
Cage	Fertilizer	1020	332
Crusher	Grain	1234	411
	Feed	1005	327
Chilian	Cement	575	183
	Bone	378	119
Granulator . . .	Coffee	652	207
Grinder	Oil Cake	498	152
	Cacao	496	151
	Bone	377	119
	With balls	191	70
	Flour (roller)	1287	426
Eccentric	–	918	292
Disintegrator . .	Rock	828	260
Harrow	Soil	831	261
Rollers	Flour	767–770	243

See also list under MILLS; GRINDING, etc., in "*Mech. Dict.*" and *supra*.

Durand & Chapitel, Fr. * "*Engineering*," xxviii 97.
Hanctin . . . . . "*Technologiste*," xxxviii. 217.
"*Scientific American Sup.*," 963.
Machine. *Jordan*, Br. . * "*Engineering*," xxx. 542.
Mill . . . . . * "*Iron Age*," xxiv., Sept. 18, p. 1.
* *Laboulaye's* "*Dict.*," ii. "*Fonderie de fer*," Fig. 928.
Barrel, *Paul* . . . . * "*Min. & Sc. Press*," xxxv. 65.
Ryerson . . . . . * "*Eng. & Min. Jour.*," xxx. 397.
And sifting mill, centrifugal, *Thompson* . . * "*Engineer*," xlviii. 61.

Pul'ver-ma-cher Bat'te-ry. A porous jar is surrounded by a silver wire which is rolled spirally, and is used as the negative pole of the element. The exciting fluid, dilute sulphuric acid, caustic potash or sal-ammoniac solution, is filled into the porous jar, through which it percolates by capillary attraction. The positive pole is a rod of zinc, the top of which is covered with caoutchouc in order to avoid accidental contacts which might short circuit the battery. The small spirals of silver wire must be far enough apart not to cause capillary attraction to take place between them.

Pumps, Wa'ter En'gines, and Wheels. See under the following heads: —

Accumulator.
Acid pump.
Aquameter.
Aquapult.
Ball hydrant.
Beer pump.
Bore-hole pump.
Brine-forcing pump.
Bucket.
Bung-bucket.
Cam-pump.
Centrifugal pump.
Cesspool pump.
Chain bucket.
Chain pump.
Circulating pump.
Compound engine pump.
Compression pump'g engine.
Counter pump.
Cup leather.
Deck pump.
Deep-well pump.
Differential pump.
Donkey pump.
Door piece.
Double-acting plunger pump.
Draining pump.
Drip pump.
Driven well.
Driven well pump.
Ejector.
Ejector condenser.
Excavating pump.
Feed pump.
Fire cock.
Fire engine.
Fire extinguisher.
Fire plug.
Fire pump.
Fixed-piston pump.
Flush-deck pump.
Force pump.
Fountain pump.
Garden engine.
Garden syringe.
Gas-compressing pump
Gas drip II pump.
Gas-fitter's pump.
Gas-tar pump.
Giffard injector.
Glass-barrel pump.
Greenhouse syringe.
Hand pump.
Hand rotary pump.
Hollow-plunger pump.
Horizontal pump.
Horse-power pump.
Hose carriage.
House pump.
Hydraulic balance.
Hydraulic engine.
Hydraulic force pump.
Hydraulic machinery.
Hydraulic motor.
Hydraulic press.
Hydraulic pressure pump.
Hydraulic pumping engine
Hydraulic ram.
Hydraulic regulator.
Hydraulic steering gear.
Hydraulic works pump.
Hydro-motor.
Hydronette.
Hydrostatic regulator.
Hydrotrophe.
Injector.
Inspirator.
Irrigating barrel.
Irrigation pump.
Irrigator.
Jigger pump.
Lift.
Locomotive pump.
Marine pump.
Mine pump.
Noria.
Odorless excavator.
Oil line pump.
Oil pump.
Oil well pump.
Oscillating pump.
Pendulum pump.
Penstock.
Plumber's force pump.
Portable engine pump.
Portable pump.
Post pump.
Propeller pump.
Pulsator.
Pump bucket.
Pumping engine.
Pulsometer.
Racking pump.
Relief valve.
Rotary pump.
Rotary force-pump.
Rotary water-engine.
Sand holder.
Sand pump.
Scoop wheel.
Ships' pump.
Sinking pump.
Siphon pump.
Sirup pump.
Slide-bar pump.
Spiral pump.
Spray nozzle.
Spreader.
Sprinkler.
Stand pipe.
Stand pipe fire apparatus.
Starting valve.
Steam jet.
Steam jet pump.
Steam pump.
Steam siphon pump.
Stone-ware pump
Street watering port.
Suction pipe.
Suction primer.
Syringe.
Tail piece.
Thief bucket.
Three cylinder pump.
Three cylinder water-engine.
Three-throw pump.
Tube well.
Tubular plunger pump.
Turbine.
Turbine pump.
Tympanum.
Vacuum pump.
Vacuum steam pump.
Vault emptier.
Vent.
Vertical pump.
Wash-room pump.
Water bucket.
Water charger.
Water column.
Water column pump.
Water crane.
Water elevator.
Water eugine

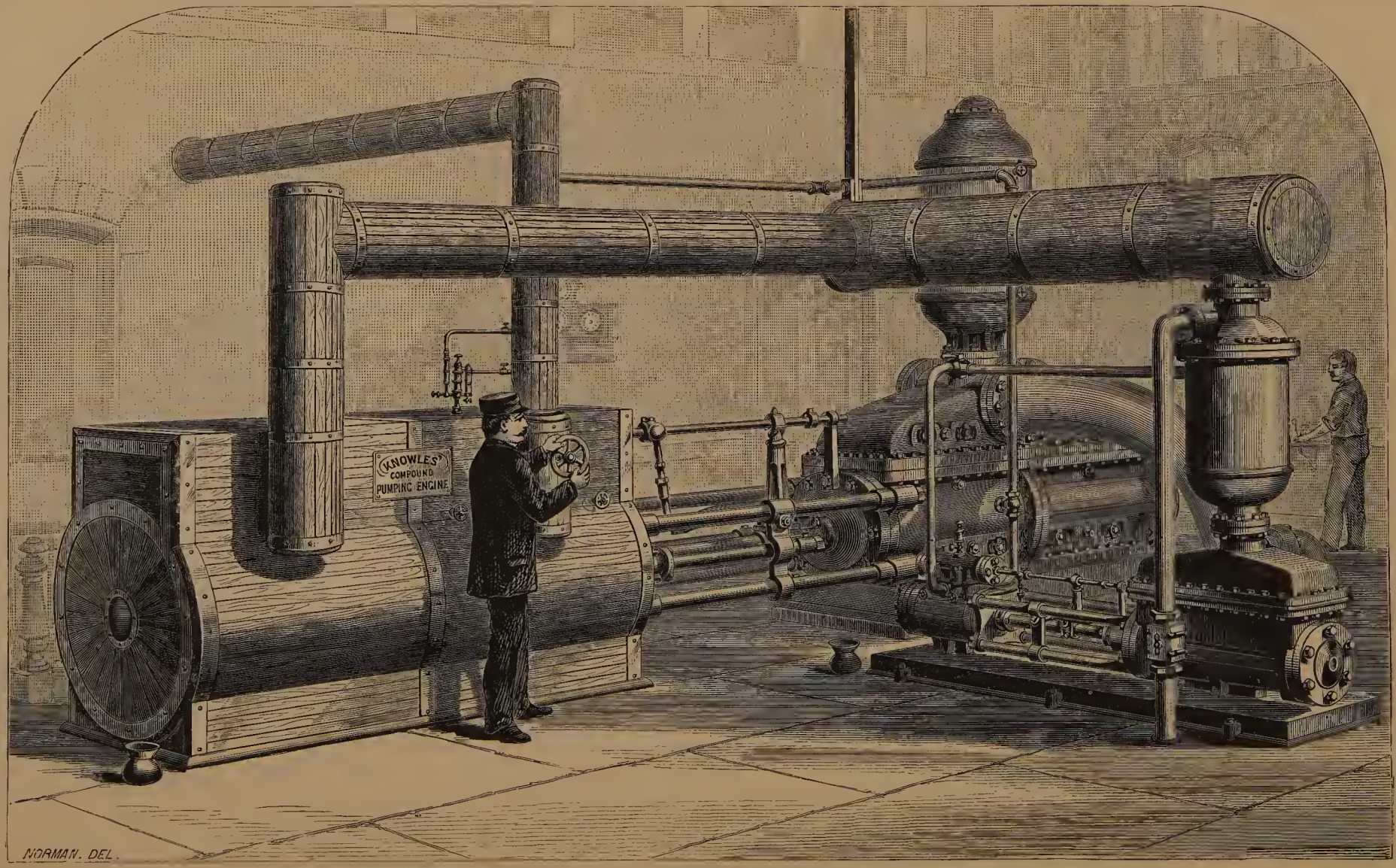


PLATE XL

KNOWLES' DIRECT-ACTING COMPOUND CONDENSING PUMPING ENGINE

See page 729

Watering can.
Water meter.
Water motor.
Water power.
Water regulator.
Water thief.
Water tower.
Water wheel.
Water wheel governor.
Water wheel regulator.
Wine pump.
Wrecking pump.
Yoke pump.

Pump Au'ger. A long auger for boring wooden logs for pump stocks, or for pipes

In a modern form the auger is surrounded by a thin metallic shell, in which the volute portion runs loosely. This shell or tube is turned true and straight; it follows and guides the auger, the shavings or cuttings being carried out through its interior. The lips or cutters of the auger are expanded at the end, so as to cut a hole just large enough for the passage of the tube.

Pump Buck'et. The reciprocated member of the pump, which carries the valve.

When valveless, it is a *plunger*.

Pump Cart. A vehicle carrying a pump and reservoir; used for watering and irrigating. See p. 508, Fig. 1473, 1474, *supra*, and references *passim*.

Pump'ing En'gine. Various forms, Cornish, horizontal duplex, are shown in Plate XLIV., p. 1828; Plate XV., p. 763, "*Mech. Dict.*"

See also list of pumps, p. 1827, *Ibid.*, and *supra*, p. 728.

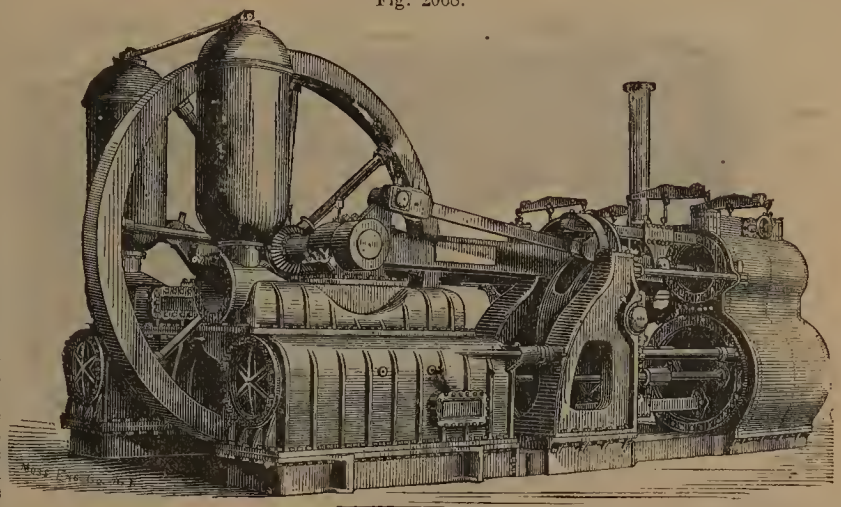
Louisville water works engine	p. 1828, "*Mech. Dict.*"
Worthington duplex	p. 763, *Ibid.*
"Leeghwater," Haarlem Lake	p. 1830, *Ibid.*
India State Railway	p. 1831, *Ibid.*
Cornish	p. 626, *Ibid.*
Centrifugal	p. 515, *Ibid.*
Draining	p. 739, *Ibid.*
Scoop	p. 2056, *Ibid.*

The engine shown in Plate XXXIX is the Knowles direct-acting compound condensing pumping engine.

The high-pressure cylinder is nearest to the water end, and to this is connected the main pistou-rod, which extends through to the water-plunger. The low-pressure piston has two smaller piston-rods which pass through sleeves east ou the outside of the high-pressure cylinder, and are connected to the main rod by a cross-head at their outer ends. All the stuffing-boxes of the steam end being on a line on the back cylinder head. The steam cylinders and steam chest are properly steam-jacketed. The valve arrangement of the high-pressure cylinder is the same as that of the ordinary Knowles steam pump, viz., a double ported flat slide valve which is surmounted and operated by a round pistou, which has a slight rotating motion imparted to it by the rocker bar, which receives its motion from a friction roll attached to the tappet arm. The slight oscillatiou of the chest piston places its parts in connection with those in its cylinder; it is then driven horizontally by the steam pressure, in which motion it carries the main slide valve, to which it is directly connected. From the front end of the valve-driving pistou is extended a rod, which operates the valve of the low-pressure cylinder. The steam is exhausted from the low-pressure cyliuder through a coil feed-water heater direct iuto the jet eondenser, which is connected to and operated by au independent air pump, as shown in engraving.

The water end of the engine is of the "inside plunger" pattern. The plunger, which is made of either iron or composition, passes through a broad ring cast in the center of the cylinder, the inner surface of which ring is either grooved to form a water-packing bearing upon the plunger, or is furuished with a stuffing-box, so that the plunger may be packed as may be required by the position of the engine. The water valves are of rubber, working upon composition seats. The suction valves arc below, and the discharge valves above the plunger. The valves are readily reached through hand holes situated immediately above the valve plates.

Fig. 2068.



Gaskill's Horizontal Compound Pumping Engine.

Fig. 2068 is the Gaskill pumping engine, built by the Holly Manufacturing Co. for Saratoga Springs, N. Y.

It is horizontal, of the rotative, non-receiver, compound-beam type. The engine has four steam cylinders, one high aud oue low-pressure in each pair; the low-pressure (42″ diam., 36″ stroke) beneath the high-pressure (21″ diam., 36″ stroke). There is one pump to each pair of steam cylinders, and each has a double-acting pluuger 20″ diam., 36″ stroke. The fly-wheel revolves between, and has its pillow-blocks upon the pump cylinders. The cross-heads of high-pressure cylinders are connected by links to a beam, which is in turn connected, one end to the erank, and the other eud to the piston-rod of the low-pressure cylinder and pumps.

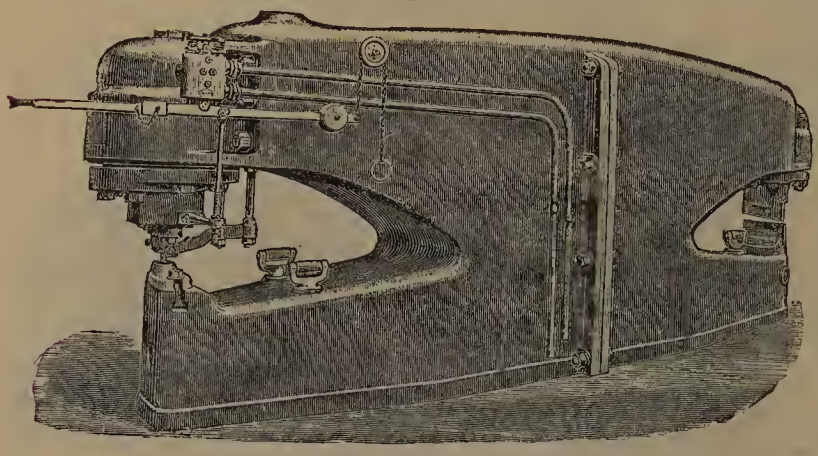
The following data were obtaiued on trial: —

Time	20 hours.
Average pressure by engine gage	74.25 pounds.
Average pressure by, in force main	95.068 pouuds.
Average vaeuum	27.295″.
Average temp. feedwater to boilers	169.175°, Fah.
Revolutions iu 20 hours	21,449.
Revolutions per minute	17.8742′.
Piston speed per minute	107.2452.
Total coal burned	6,750 pounds.
Discharge per revolution	187.125 gallons.
Delivery at 18 revolutions per minute	4,850.280 gallons.
Net absolute duty	108,793,525 pounds

Duty: number of pounds lifted one foot high by consumption of 100 pouuds good authracite coal.

Barrow	* "*Scientific Amer.*," xxxix. 324.
Engine, compound duplex, *Blake*	* "*Am. Man.*," July 30, 1880, p. 13.
Compound, *Blake*	* "*Manufact. & Builder*," xii. 73.
Knowles	* "*Manufact. & Builder*," xii. 97.
Rotary, *Brakell*, Br.	* "*Engineer*," xliv. 106, 211.
Bushtiehrad mines, Bohemia	* "*Engineering*," xxvii. 155.
Household, *Carr*	* "*Manuf. & Builder*," viii. 211.
Chiswick drainage Works. *Hathorne & Davey*	* "*Engineering*," xxvii. 476.
Clausthal, Ger.	"*Iron Age*," xxii., Oct. 10, p. 20.
Covington, Ky.	"*Scientific American Sup.*," 55.
Croydon, Br.	* "*Engineering*," xxiv. 356.
Compouud, *Davey*, Leeds, Br.	* "*Engineering*," xxii. 421.
Heater, feeder, and condenser, *De Beaumont*	* "*Iron Age*," xx., Aug. 30, p. 1.
Dean Bros.	* "*Scientific American*," xl. 243.
Dean	* "*Scientific Amer.*," xxxiv. 128.
Lift and force, *Daylass*	* "*Iron Age*," xvii., March 16, p. 9.
Engine, caloric, *Ericsson*	* "*Scientific American*," xliii. 326.
Farcot et fils, Fr.	* "*Engineering*," July 26, 1878, p. 70.
Underground, Fohnsdorf	"*Scientific American Sup.*," 1232.
Geared, *Fonderie de l'Horme*	* "*Engineering*," xxvi. 294. 334.
Force pump, *Guilds*	* "*Scientific American*," xlii. 4.
Ships, *Gwynne*, Br.	* "*Engineer*," l. 91.
And winding eng., Hartley Pit Colliery, Br.	* "*Engineer*," xli. 298.
Holly	* "*Scientific American*," xxxix. 95.
	* "*Engineering*," xxviii. 366, 376.
	* "*Scientific American Sup.*," 2219.
Cornish, Hull	* "*Sc. Am. Sup.*," 264, 265, 357.

Fig. 2069.



Punch and Shear. (*Toulon, Fr. Dock-yard.*)

Cornish, Hull, Br. . . * "*Engineer*," xli 133, 136, 156.
Lawrence, Mass, *Leavitt* * "*Scientific American Sup.*," 1039.
Lawrence, Mass. . . . * "*Engineering*," xxvii. 58.
Rotative, zinc mines, Lehigh . . . . . * "*Engineer*," xli. 446, 470, 488.
* "*Scientific American Sup.*," 502.
Levers colliery, Br. . * "*Engineer*," xlvii. 292, 296.
Mathieson . . . . * "*Scientific American Sup.*," 164.
Machinery, (Mid Calder) "*Scientific American Sup.*," 196.
Force pump, *Nason* . . * "*Manuf. and Builder*," ix. 193.
Pumping engine, North Stavely, Br. . . . . * "*Engineer*," xlix. 368, 424.
Pearn, Engl. . . . * "*Scientific American Sup.*," 1059.
Pittsburg . . . . . "*Scientific American*," xlii. 84.
Providence, R. I. . . . * "*Engineer*," xlii. 324.
Reciprocating barrel . * "*Scientific American*," xl. 355.
Mining, *Rittinger*, Ger. * "*Engineering*," xxx. 158.
Haud, *Robaugh* . . . * "*Scientific Amer.*," xxxvi. 162.
Sprengel, *Rood* . . . * "*Scientific American Sup.*," 3825.
Rotative, 450 horse power. Salt mine, Ligcberg, Pruss. . . . . * "*Engineer*," xliii., 117, 144, 241.
Portable, *Shand, Mason & Co.*, Br. . . . . * "*Engineer*," xlvi. 286.
Cam pump.
Smith, Valle & Co. . * "*American Miller*," vii. 7.
Plunger pump, S. Durham colliery, Br. . . * "*Engineer*," xlvii. 79.
Machinery, Effra Creek, Thames . . . . . * "*Engineer*," xlviii. 306.
For hydraulic presses, direct act., *Tweddell*, Br. * "*Engineer*," xlv. 84.
Twickenham Sewage Works, Br. . . . . * "*Engineer*," xlviii. 362.
Underground . . . . "*Scientific American Sup.*," 660.
Erin colliery, Westphalia * "*Engineer*," xlii. 238.
Underground, Erin colliery, Westphalia . . "*Van Nostrand's Mag.*," xv. 284.
Walker . . . . . * "*Scientific American Sup.*," 292.
Deep well, *Watson* . . "*Scientific Amer.*," xxxix. 309.
Bilge, *Jas. Watt & Co.*, Br. * "*Engineer*," xliii. 250.
Machinery works.
Worthington . . . . * "*Scientific American*," xliii. 143.
Duplex, *Worthington* . * "*Engineer*," xlii. 364.
Worthington . . . * "*Scientific American Sup.*," 887.
Auxil., yacht "Comet" * "*Engineering*," xxvii. 568.
"Yellow Jacket," Mine * "*Van Nostr. Mag.*," viii. 476.
Hydraulic, Zurich . . * "*Engineer*," l. 165.

Report of *Chas. E. Emery*, "*Centennial Exhibition Reports*," includes those of —

Worthington (duplex) *.
Philadelphia engine (beam) 1800 *.
Knowles (direct action).
Blake (direct action).
Andrews (centrifugal) *.
Andrews (oscillating) *.
Heald & Co. (centrifugal) *.
Bagley & Sewall (rotary) *.

Pump Joint Ma-chine'. A machine for boring out and turning down the respective ends of the wooden sections where they meet in coupling to form the stocks of pumps, or which are thus united by socket joint to form pipes for conveyances of water.

The machine consists of a heavy steel spindle, which is placed in the bearings of a lathe head stock. The spindle has a screw chased to fit chucks of different sizes. The end of the spindle has a centering collar, changeable for different sizes by removing a nut, the cutting-knife in the chuck extending the whole length; a second knife at the end, which works at right angles to the first cutter, finishes the end of the stock.

In operating, the stock is placed in a rest, the bole in the stock fitting the self-centering collar. The stick is fed in by hand, and a perfect joint made, each one of the same size. There are two sizes of chucks, 3″ and 3½″ diameters.

Pump Valve. The moving piece in a pump which opens or closes to allow the water to pass or prevent its return, respectively.

See list under PUMPS: VALVES.

Perreaux's flexible valve is shown in Fig. 1061, p. 347, *supra*.

Painter's flap valve for thick and viscous matters has a flexible valve flap which is arranged to close and guard the port, by an extensive superficial contact of said flap and a fixed coincident surface.

Punch and Shear. Punches, single or combined with shears, are shown on pp. 1833, 1834, "*Mech. Dict.*"

The Tweddell punch and shear, to cut 1¼″ thickness, erected in the dock-yard of Toulon, France, is shown in Fig. 2069. The respective ends are separable so as to make two distinct machines. Each tool has its own ram, valves, and water supply; the latter is from an accumulator loaded to 1500 pounds per square inch.

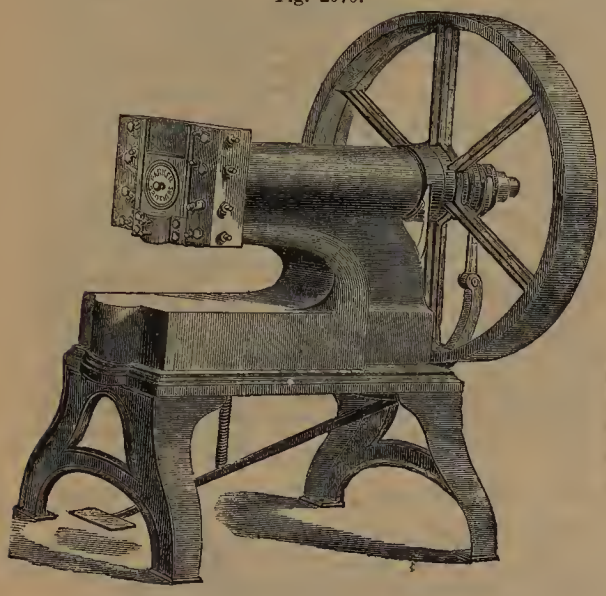
Punch and shearing machine, *Berry & Sons*, Br. * "*Engineering*," xxii. 502.
"*Iron Age*," xix., March 15, p. 24
Berry & Son, Engl. . * "*Scientific American Sup.*," 930.
Lyon . . . . . * "*Iron Age*," xxi., May 2, p. 18
Hydraulic, *Tweddell*, Toulon, Fr. . . . . * "*Engineering*," xxii. 441.
Hydr., quadruple, *Tweddell*, Br. . . . . * "*Engineer*," xlii. 228.
Press . . . . . * "*Sc. Amer.*," xli. 166, 179, 194.
And straightening mach., *Landue Siemens Steel Works* . . . . . * "*Engineer*," xlii. 25.
Punching mach., *Baer* . * "*Scientific American*," xxxv. 166.
For plates and angle irons, *Bemast* . . . * "*Engineering*," xxii. 538.
With automatic table, *Bemast* . . . . . * "*Engineering*," xxx. 228.
Bush . . . . . * "*Min. & Sc. Press*," xxxiv. 209.
Metal, *Robertson* . . . * "*Scientific American*," xxxvii. 50.
Swing weight . . . . * "*Engineer*," xlix. 71.
Hydraulic, *Tweddell* . * "*Scientific Amer.*," xxxvi. 102.
Punching nuts.
Hooper & Townsend . * "*Scientific American Sup.*," 1855.
Press, *Ferris & Miles* . * "*Engineer*," xli. 463.
Press, power, *Merriman* * "*Iron Age*," xvii., Feb. 17, p. 20.
* "*Engineer*." xli. 485.
Press, "Peerless" . . * "*Scientific American*," xliii. 83.
Stiles . . . . . * *Thurston's* "*Vienna Rep.*," ii. 239.
Shaping and sharpening.
Thomson, Sterne & Co., Br. . . . . * "*Engineering*," xxviii. 237.
Spiral, *Kennedy* . . . "*Iron Age*," xxi., May 23, p. 5.
Factory, *Stiles & Parker* * "*Scientific American*," xlii. 159.
Punching iron, paper on "*Scientific American Sup.*," 1071.

Punch'ing Press. Fig. 2070 is a view of a Stiles and Parker press with eccentric adjustment.

The slide of the press receives its reciprocating motion from a crank-pin which revolves within an eccentric ring in the sliding block. This block traverses in the oblong mortise in the slide as the crank revolves, thus imparting the motion of the crank to the slide. By bringing the eccentric out of its position by a key and turning the same by a lever, the punch may be adjusted to the die to the hundredth part of an inch.

The amplitude of the motion remains the same, but the range is changed so as to suit dies of various thickness above the bed plate.

Fig. 2070.



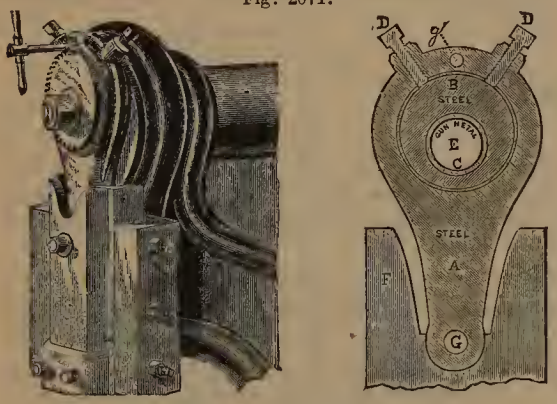
Fowler Press with Eccentric Adjustment.

The eccentric is a substitute for the former plan of placing shives of metal above and below the box.

The Stiles adjustment is shown in Fig. 2071.

The upper end of the pitman *A*, which connects the slide *F* with the crank-shaft *E*, is bored out and enlarged to receive the eccentric disk *B*. The lower end of the pitman is secured to the slide by the pin *G*. The disk *B* is bored out of center, and fits the crank shaft loosely to allow the interposition of a gun metal bushing. The disk is turned by the pinion *g*, and held by the screws *D D*. The pinion is turned by a gear wreuch.

Fig. 2071.



Punching Press. (Stiles Adjustment.)

By this device the amplitude of the stroke is not changed, but the punch is raised or lowered to the direction in which the disk is turned. The two set-screws will hold the eccentric-ring under the greatest strain. In this arrangement the securing of the adjustment will not throw the bearings out of line, but will leave the pitman as true and free to work as before.

In the Merriman press the adjustment is by means of a right and left threaded screw and two threaded sockets.

Punc'tur-ing In'stru-ment. (*Surgical.*) A term specially applied to the *sonde-a-dard* used in supra-pubic lithotomy; the instrument for puncturing, — speaking in general terms — are so numerous as to make the recitation tedious. See list under Surgical Instruments.

Pun'jam. (*Fabric.*) A strong cotton cloth made at Vizagapatam, in India. The meaning of *punjam* is "120 threads," and the cloth is denominated 10, 12, 14, up to 40 punjam, according to the number of times 120 is contained in the number of threads in the warp.

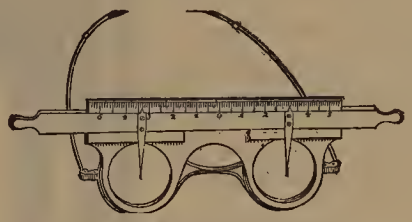
The loose night dress with drawers, *punjanias*, is named from this cloth; or, perhaps, *pijama*, leg cloth. *Jama* is a full dress coat.

Pun'ty. (*Glass.*) 1. Probably from It. *punto*, a point. A glass decanter, for instance. It is said to be cut in *punties* when the ornamentation consists of dots or cup-like depressions, usually circular but sometimes oval.

2. The glass blower's tube. *Ponty, pontil.*

Pu'pil-lom'e-ter. (*Surgical.*) An instrument for measuring the distance between the axes of the pupils.

Fig. 2072.



Chevalier's Pupillometer.

Pu'ri-fi'er. (*Milling.*) A separator to remove bran scales and flour from grits or middlings; a process repeated between each grinding in the *high-milling* process. See Middlings Purifier; Grits Purifier.

In the process of high milling, in the step by step reduction of the grain, starting with the pointed kernels, there are with each grinding three products: coarse fragments, with much bran attached; less coarse fragments, with less bran attached; and minute fragments, with little or no bran attached. These are separated from each other by the sifting and purifying machines. Each of the several products is again subjected to grinding, and the product in each case again sorted into grades, and so on, until the last traces of the white interior of the berry have been separated from the dark hull and graded.

Purse Net. (*Fishing.*) A net stretched on wires, similarly to an umbrella, and, when ready to hoist, closed like a purse. See Drop-net, Fig. 3317, p. 1522, "*Mech. Dict.*"

Purse Seine. (*Fishing.*) A seine which is closed by pulling upon a line or lines to inclose the fish. They have wings and a bag, and are used in the mackerel fishery.

"Purse seines range in length from 120 to 220 fathoms, and from 750 to 1,000 meshes in depth, reaching the depth of 20 to 30 fathoms of water. The average mesh is $2\frac{1}{8}$". They are made of fine Sea-Island cotton twine, and cost from $750 to $1,500 complete. The pursing weight varies from 100 to 150 pounds." — "*Bulletin U. S. National Museum.*"

Thimbles and snatch-block are used for the running rope which closes the seine.

Push Car. (*Railway.*) 1. A light four-wheeled car used in transporting light matter, express packages, mail-bags, etc., in transferring from one train to another, or otherwise.

2. A car used as an intermediate, to connect a locomotive with a train in moving the latter up or down an incline leading to a ferry-boat. See Ferry Push-car.

Push'er. (*Hat-making.*) One form of hat-fulling machine, which see.

Pyr-he'li-om'e-ter. An instrument to measure the heat of the sun.

Pouillet's heliometer is shown in Fig. 4056, p. 1837, "*Mech. Dict.*"

The pyrheliometer of A. Crova is described in "*Comptes Rendus*" and "*American Journal of Science and Art.*" — "*Scientific American Sup.*," 234.

Ericsson's colorometer, for measurement of solar heat, * "*Scientific American Supplement*," 1103.

Solar engine, * "*Scientific American*," xli. 67.

Py-ri'tes Burn'er. An apparatus in which pyrites is burned to obtain sulphuric acid. See report of *Prof. Jackson's*, "*Paris Exposition Reports*," 1878, vol. iv., p. 10, *et seq.*, having references to those of: —

Hemptinne.
Bode.
Perret.
Maletra.
Ilasenclever & Helbig.
Walker.
MacDougal.
Spencer.

Holloway, "*Nature*,"
"*Van Nostrand's Magazine*," xx. 387.
"*Iron Age*," xxiii., March 27, 15.

Py-rom'e-ter. Brown's portable hand pyrometer is used as a test gage and check upon those pyrometers which are constantly inserted in the hot blast to ascertain if they are correct and in working order.

Fig. 2073.

Brown's Pyrometer.

It may be described as a metal conducting tube open at each end, for the free current of the hot blast; within the tube is a thin expansion strip, conveying its motion to a dial upon a bar outside of the conductor. On applying this instrument to any orifice in the blast pipe, the hot air rushing through will give an accurate indication in less than one minute. By having several plug holes in the length of the blast pipe, its temperature at any part may be ascertained. It is useful to ascertain the loss of temperature between the stove and tuyere, and the gain derived from covering the pipes.

The instrument is set at the atmospheric temperature previous to the trial, by an adjusting screw.

* "*Sc. American Sup.*," 523, 2732.
Brown . . . . . * "*Iron Age*," xviii., Dec. 7, p. 24.

Byström's (Swedish) "*Ordnance Report*," 1878, Plates IV., V., accompanying Appendix R, 3, and p. 375.

Hot blast, *Hobson* . . * "*Engineer*," xli. 484.
Regulator, *Hobson* . . * "*Technologiste*," xxxvii. 221.
Main . . . . . * "*Technologiste*," xxxvii. 220.

Py'ro-phore. The name of a body which has the faculty of inflaming by contact with air or water. See pp. 1838, 1839, "*Mech. Dict.*"

The self-lighting signal logs which are thrown overboard to rescue men in the water, inflame on contact with the water. This forms a guide for the man to swim to, and to the boatmen who go to his rescue. The self-luminous safety buoys of the French Marine Service have phosphide of calcium. See BUOY; LIFE BUOY.

The property seems to be due to the rapid absorption of oxygen by the combustible body. Certain metallic oxides, that of iron, for example, reduced by hydrogen at a low temperature, become extremely pyrophoric. By calcining in a luted crucible 6 parts of lamp-black mixed with 11 of sulphate of potassa, a compound of sulphur and carbon is obtained which inflames with great facility by contact of the air.

"*Manufacturer & Builder*" . . . . . xi. 24.

Py-ro-ste're-o-type. A process in which an intaglio is burnt in wood to serve as a mold in which a printing plate in relief may be cast.

It is said to be used in France in making music plates, and the apparatus is figured in *Laboulaye's* "*Dictionnaire des Arts et Manufactures*," tome iii., article "*Stéréotypie*."

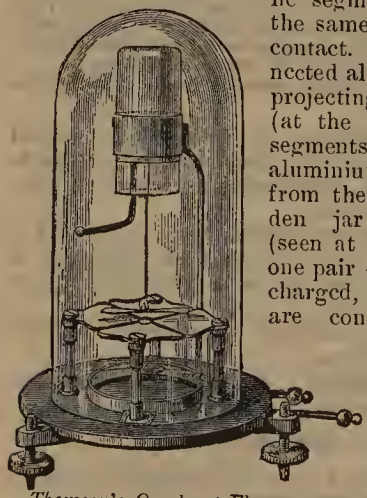
A block of lime or linden wood, with the design traced upon it, is secured upon the table, and steel plugs of forms suited to the various signs, keys, or notes, and heated by gas, are brought down upon it, to burn out holes corresponding to the shapes of the tool. One tool at a time occupies the plunger-rod, and after all the required impressions have been made by it, another is substituted, and so on.

Py-rox'y-line. See GUN COTTON, COLLODION, *supra*.

Q.

Quad'rant E'lec-trom'e-ter. A form of electrometer invented by Sir William Thomson.

Fig. 2074.



Thomson's Quadrant Electrometer.

It consists of four metallic segments supported in the same plane, but not in contact. They are connected alternately with two projecting knobs and balls (at the right). Over the segments hangs a strip of aluminium by a fine wire, from the inside of a Leyden jar feebly charged (seen at the top). If now one pair of the sectors are charged, while the other are connected with the earth, the strip of aluminium will move towards them if the charge is opposite to that of the aluminium rod and the jar; but if the charge is of the same kind, repulsion will take place and the aluminium strip will move away from them and over the other segments that are not charged. In order to give a directive force to the aluminium strip a small compass needle is attached to it. In order to observe and measure slight motions of the aluminium strip, a small mirror is attached to it, and a ray of light reflected by it upon a scale placed against the wall; the least turning of the mirror will cause this ray of light to travel sideward — in fact, it will act like a very long hand on a dial against the wall.

It is evident that such a delicate instrument should always be placed under a glass shade, in order to prevent disturbances by air currents, such as those generated by breathing near them. In this case the Leyden jar is also under the glass shade, so as to keep it charged longer; it is charged by the curved rod seen under it, which is connected with its inside covering, while the outside covering is connected exteriorly with the earth, when it is charged, but after being charged the connection may be severed. The two knobs seen at the right side below serve to charge the segments.

Bifilar suspension . . "*Journal Soc. Tel. Eng.*," v. 481.
Thomson . . . . . * "*Manufact. & Builder*," xi. 253.
* *Prescott's* "*Electricity*," p. 947.
* "*Engineering*," xxiii. 259.

Quad'ri-cy-cle. A four-wheel vehicle adapted to be propelled by the feet.

The bicycle and tricycle are respectively two and three-wheeled.

"*Railroad Gazette*" . . . . . * xxii. 597.

Quad'ri-form Group Flash'ing Light. A peculiar lighting apparatus for light-houses, invented by J. R. Wigham, and first erected at Galley Head, a promontory on the coast of Cork, Ireland, between Cape Clear and the Old Head of Kinsale.

The quadriform arrangement consists of 32 lenses arranged in four tiers, with a gas-light in the focus of each. As the lenses touch each other the lights blend at a few yards distance and form a pillar of light 13′ high and 3′ broad.

The *group flashing* denotes that the flashes from

the lenses instead of being *single* flashes, as usually exhibited at light-houses, are each of them, by the repetition, extinction, and reignition of the gas, broken up into four or five beams, which constitute a *group* of flashes recurring at regular intervals, presenting a distinctive appearance. The interval between the groups of flashes is 1 minute; between the flashes in each group 2 seconds. The flashing is accomplished by the same clock-work machine by which the lenses are caused to revolve.

Quad'ru-ple Coil Spring. A car spring made of four coils; in a nest, as in *s*, Fig. 1143, p. 483, "*Mech. Dict.;*" or merely associated in the manner indicated at *u*, same figure.

Quad'ru-ple Nose Piece. (*Optics.*) An attachment to a microscope; a piece having four object glasses of different powers, either of which may be brought into apposition with the body of the microscope; avoiding the trouble of unscrewing and attaching a different power.

Double nose-piece, Fig. 3335, p. 1534, "*Mech. Dict.*"

Quad'ru-plet. Four united acting together, as of springs. *s*, Fig. 1143, p. 483, "*Mech. Dict.*"

Quad'ru-plex Tel'e-graph. An amplification of the duplex system; by the quadruplex system, four messages may be sent over the same wire, simultaneously, two in each direction. See Duplex Telegraph, p. 764, "*Mech. Dict.*"

It was used by Prescott & Edison in 1874, by Nicholson of Cincinnati, Myer of Paris.

Cf. . . . . . * "*Engineer*," xlvi. 5.
Farmer (1858) . . . . "*Scientific American Sup.*," 14.
Muirhead & Winter . . * "*Telegraphic Journal*," vii. 223.
Paper on, *Pope* . . . * "*Telegraphic Journal*," iv. 2.
Smith . . . . . * "*Telegraphic Journal*," vi. 198.
Working . . . . . * "*Telegraphic Journal*," iv. 231.

Quan'ti-ty. (*Electricity.*) The amount of electricity generated in a given time.

Quar'ry-faced Stone. (*Stone Cutting.*) Masonry stones, the faces of which are left untouched, as they come from the quarry.

As distinct from hammer-faced, pitch-faced, tooled, etc.

Quar'ter Bend. A curved section of pipe subtending an angle of 90°. *c*, Fig. 295, p. 97, *supra.*

Quar'ter-ing Ham'mer. A steel hammer of from 1 to 2 pounds weight used in blocking out masses of flint for flaking. See Blocking Hammer.

Quar'ter-ing Ma-chine'. A machine for quartering driving wheels on their axles; *i. e.*, boring the wrist pin-holes at 90° distance apart. Fig. 4067, p. 1844, "*Mech. Dict.*"

London and N. W. Ry. . * "*Engineering*," xxviii. 260.
Urquhart, Br. . . . . * "*Engineer*," xlvii. 389.

Quar'ter Sa'ver. (*Knitting.*) A device attached to a knitting machine to prevent the work from running off when the thread breaks or runs out. — *Cooke.*

Quar'ter Tack'le. (*Nautical.*) A tackle used in hoisting aboard water, etc.

Quar'ter-turn Belt. One which has a twist of 90°, transmitting motion between pulleys on shafts at right angles to each other.

Nine dispositions of * *Cooper's* "*Belting*," Phila., 1878, p. 172.

Quar'ter-turn Goose'neck. A bent pipe coupling having a turn of 90°, and connecting the discharge pipe with the nozzle.

Quartz Mill. A machine for crushing auriferous quartz. See Figs. 4068–4078, pp. 1844–1846, "*Mech. Dict.*"

Hand power, *Eaton* . . * "*Min. & Sc. Press*," xxxviii. 217.
Rotary, *Howland* . . * "*Min. & Sc. Press*," xxxiv. 25.

Queens'ware. (*Ceramics.*) 1. Queen Charlotte's ware, now known by the contracted title. A celebrated cream-colored Wedgwood ware. It is of white clay and flint.

2. A form of stone ware also the invention of Wedgwood, and occupying a position between porcelain and pottery. See Stone Ware.

Quick'silver Bat'te-ry. See Mercury Battery.

Quick'silver Fur'nace. See Mercury Furnace.

Qui'et-ing Cham'ber. (*Steam.*) An arrangement to prevent the noise incident to blowing-off of steam. The sides of the exhaust pipe have numerous small branch tubes, the sum of their areas equal to that of the main pipe.

Shaw's . . . . . See Fig. 987, p. 320, *supra.*
* "*Railroad Gazette*" . . . . xxiii. 141.
* "*Min. & Sc. Press*" . . . . xxxvi. 313.

Quin'tu-plet. Said of springs when five of similar type are associated in a group.

R.

Ra'cer. The British name for a traverse circle beneath the chassis of a gun. See Circle; also Plate VIII., p. 448, "*Mech. Dict.*"

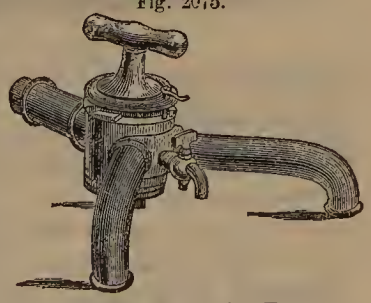
Rack Car. (*Railway.*) A freight car with open slat sides, and a roof. Used for iron in pigs, pipes, and castings; oil in barrels; coke, etc.

Rack-cut'ting Ma-chine'. A machine tool for cutting the teeth of racks. It is a modification of the nulling machine, standing on a column and having, in the size shown (Fig. 2076), a table 31″ long, with a vertical adjustment of 6″, and a transverse horizontal adjustment of 17″. The spindle carries two cutters for *blocking-out* and *finishing* the tooth at the same time. Several racks may be cut at once or a single rack up to a width of 6″. Any pitch and any length of rack can be cut. The feed is automatic, with self-acting, adjustable stop-motion. The driving-spindle has a cone of two grades, and actuates the cutter spindle through the medium of gears.

Rack'ing Fau'cet. A faucet for transferring wines or beer from vats to casks.

Used in running wines off their lees after fermentation or fining; also in filling beer kegs from vats.

Fig. 2075.

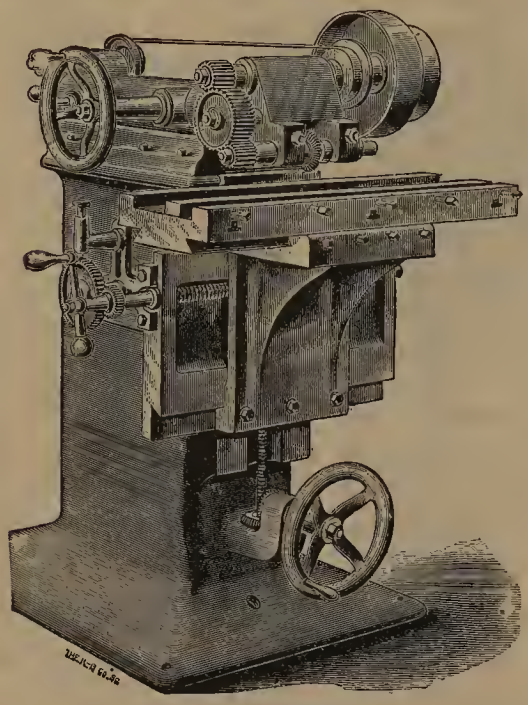


Double-armed Racking Faucet.

The two nozzles enable two kegs to be filled at once, keeping the racking-off uninterrupted. The small spigot in the middle enables the liquid to be examined at any time.

Rack'ing Pump. A pump used in the transference of wines from vats to casks and from cask

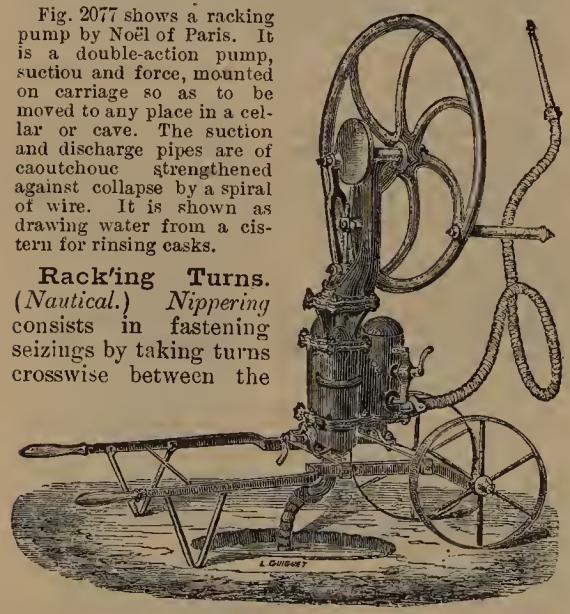
Fig. 2076.



Rack-cutting Machine.

to cask when the difference of level prevents the use of siphon or faucet.

Fig. 2077.



French Racking Pump.

Fig. 2077 shows a racking pump by Noël of Paris. It is a double-action pump, suction and force, mounted on carriage so as to be moved to any place in a cellar or cave. The suction and discharge pipes are of caoutchouc strengthened against collapse by a spiral of wire. It is shown as drawing water from a cistern for rinsing casks.

Rack'ing Turns. (*Nautical.*) *Nippering* consists in fastening seizings by taking turns crosswise between the parts to jam them; and a *racking turn* is a round turn before each cross.

Rack Rail'way. A form of railway having a rack between the rails, engaged by a gear wheel on the locomotive. See p. 1852, "*Mech. Dict.*," and references *passim*.

See also: "*Scientific American Sup.*" * 1106, * 1313.
"*Engineering*" . . . . . * xxiii. 413.
"*Van Nostrand's Mag.*" . xxii. 9; xxiii. 230.

Ra'di-al Ax'le Box. One which preserves its position radial to the track, even when the car is upon a curve. — *Widmark*, Br.

"The axle-box has planed parallel sides, and is free to slide in a direction which is rectilinear and horizontal, but inclined to the axle of the wheels. The box at the opposite end of the axle is inclined in the opposite direction, so that, when the wheels and axle deviate toward one side in consequence of the curvature of the road, the axle is simultaneously set in an oblique position to the engine frame, but radial to the road, one end being advanced in relation to the frame, while the other is drawn back by the inclined form of the axle-boxes and the intermediate guides.

"As the sides of the axle-boxes are parallel planes, and as there are no flanges, the axle-boxes are free to turn round a horizontal axis which is at right angles to these side planes. Thus one axle-box may rise and the other fall in the guides, as required by the state of the road." — "*Engineer.*"

Ra'di-al Dril'ling Ma-chine'. A vertical drilling machine, the operating portion of which is adjustable on a horizontal arm projecting radially from the vertical pillar. It is used for drilling a row of holes on an object placed on the table beneath. Fig. 4099, p. 1852, "*Mech. Dict.*"

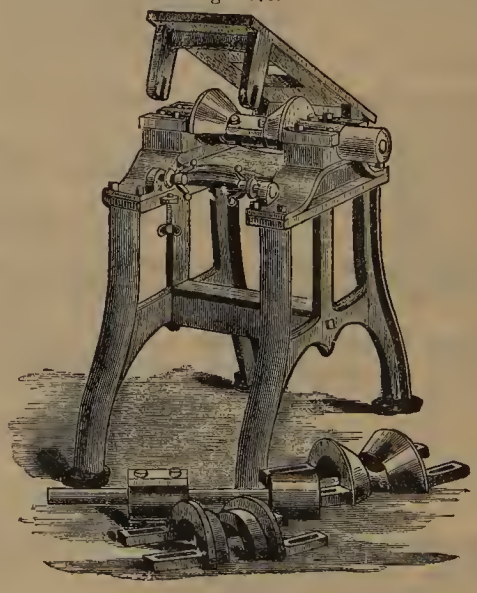
See also the following references: —

Arqueth, Br. .	* "*Engineer*," xlv. 163.
	* "*Engineering*," xxiv. 16.
	* "*Scientific American Sup.*," 1347.
Box & Co.	* "*Iron Age*," xviii., Nov. 2, p. 20.
	* "*Iron Age*," xxiv., Dec. 11, p. 1.
Sharpe, Stewart & Co., Br.	* "*Engineering*," xxv. 366.
	* "*Scientific American*," xxxix. 8.
English	* "*Scientific Amer.*," xxxvii. 111.
	* "*Scientific American*," xxxviii. 51.

Ra'di-al Pla'ner. A machine for rounding off the corners of stuff, especially in implement and carriage work. Also known as a *rounding machine*, *cornering machine*, or *chamfering machine*; see the latter.

It performs some of the duties of a spoke-shave. It is used for forming pieces of hard wood in irregular shapes and

Fig. 2078.



Radial Planer.

planing smooth where the grain of lumber sets different ways on the same piece. With the adjustable top bed the machine forms a smooth plane for plane surfaces. With a side-jointing head it is adapted for squaring off the ends of hard wood pieces.

Ra'di-a'tion Ther-mom'e-ter. One specially adapted for marking the results of radiation from grass, and for ascertaining the direct heating powers of the rays of the sun.

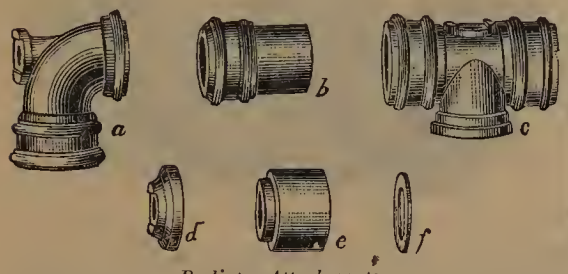
The former are termed *terrestrial* radial thermometers, and the latter *solar* radiation thermometers.

The terrestrial instrument is a minimum spirit registering thermometer, with a forked tube taking the place of the bulb. It is graduated on its own tube, and inclosed in an outer glass jacket. When in use, it is supported with one end on a fork, and the bulb is placed resting on the grass.

The solar instrument is a registering maximum thermometer, with its bulb blackened to facilitate the absorption of solar heat. The instrument is inclosed in a large outer glass tube from which all air has been removed, in order to prevent vitiation of the result, by the communication of its own heat by the air to the bulb.

Ra′di-a′tor. A heating chamber or coil in an apartment. Various forms are shown in Figs. 4101–4104, p. 1853, "*Mech. Dict.*" Fig. 2079 shows a group of accessory parts.

Fig. 2079.



Radiator Attachments.

a. Radiator ell (or L).
b. Radiator socket.
c. Radiator tee (or T).
d. Cap.
e. Separating piece.
f. Ring packing.

See also MANIFOLD; RETURN BEND; COIL

Ra′di-o-graph. An instrument invented by Waistanley for the measurement and record of solar radiation.

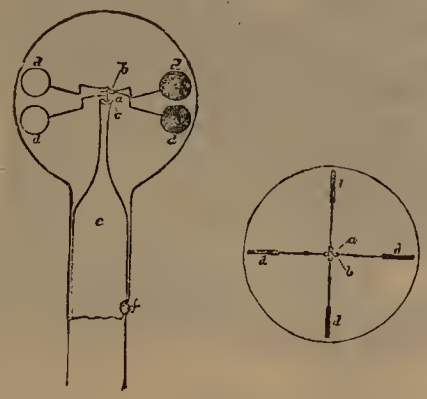
* "*Engineering*"	xxx. 366.
"*Scientific American Supplement*"	4081.
"*Scientific American*"	xliii. 104.

Ra′di-om′e-ter. An instrument invented by Mr. William Crookes for demonstrating the mechanical action of light, and the conversion of radiation into motive power.

According to Prof. Frankland, the movement is due to heat.

The instrument consists of four arms of some light material, to the ends of which are fixed thin disks of pith with one side black and the other white, the black sides for the

Fig. 2080.



Radiometer.

four disks all facing the same way. These arms cross each other at right angles and are balanced at their center points on a hard steel point, *a*, resting on a jewel-cup, *c*, so that they may freely revolve in a horizontal plane. A thin glass globe, drawn out to a tube at the lower part so as to form a support, incloses the whole, and is exhausted to the greatest attainable vacuum and hermetically sealed.

When this instrument is placed subject to the influence of light, the arms rotate with greater or less velocity directly in proportion to the intensity of the incident rays.

Prof. Crooke's "*Lecture on Radiant Matter*," British Association for the advancement of Science, Sheffield Meeting, Aug. 22, 1879. Queen, Phila.

Cf. as a light measurer	"*Telegraphic Journal*," vi. 87.
Principles of, *Baldwin*	* "*Scientific American*," xlii. 98.
Barrett	"*Scientific American Sup.*," 1974.
Crookes	* "*Engineering*," xxv. 155, 195, 253, 293.
(20 Figs.), Br.	* "*Engineer*," xlviii. 170.
(20 Figs.)	* "*Engineering*," xxviii. 165, 187.
	"*Scientific Amer.*," xxxiv. 313; xxxv. 23, 79, * 176, 242.
Paper by *Crooke*	"*Sc. Amer. Sup.*," 408, 523, 582, 667, 699, 908, 1187.
Frankland	"*Scientific American Sup.*," 809.
Webster	
Young	"*Scientific American Sup.*," 1093.

Ra′di-o-phone. A modification or application of the radiometer; an instrument for the production of sound by radial energy.

Ra′di-us Bar. A bar or pivoted link which permits any adjustment in which the link forms a radius.

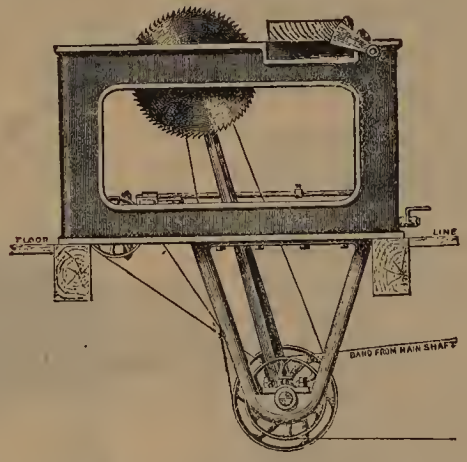
A bar or pivoted link which moves on a center at one end, and at the other is connected to an object to preserve its relative distance, and permit adjustment concentric to the object so connected; *i. e.*, any adjustment or motion relative to the said center while preserving the relative distance.

See the parallel motion in the Cornish steam engine, Fig. 3548, p. 1630, "*Mech. Dict.*"

The hinged link is used in harvesting machines also.

Ra′di-us Saw. A machine saw in which the circular saw is journaled on the end of a radial arm, pivoted below to a shaft, on which is placed the driving pulley. By a pedal or hand arrangement the saw is drawn forward so as to cross-cut the timber on the bench, and falls back by gravity when the work is done.

Fig. 2081.



Ransom's Radius Cross-cut Saw.

It is a form of cross-cutting machine similar in duty, but not in construction, to the TRAVERSE SAW, Fig. 6626, p. 2619, "*Mech. Dict.*"

Ra-fa-el′le Ware. (*Ceramics.*) A name given to *Majolica* owing to so many of Rafaëlle's designs being found on that species of pottery.

Raft. See Figs. 4105–4108, pp. 1854, 1855, *Mech. Dict.*"

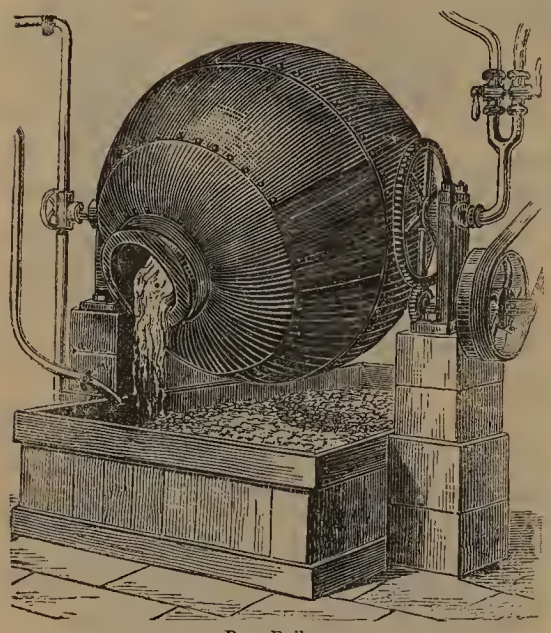
Raft, Life, and Davits, *Cramp*	* "*Engineering*," xxii. 262.

See also PORTABLE RAFT; LIFE BOAT; *supra.*

Rag Boil′er. The rag-boiler is fixed or movable, heated by open fire or by steam; is generally rotative, which gives a continual agitation to the contents.

In the illustration, the boiler is spherical, turning on its axis. Water or steam is admitted at the ends for rinsing or boiling, as the case may be, and

Fig. 2082.



Rag Boiler.

at one end is the gearing for rotation, either to agitate the contents during the process while the cover is closed, or to discharge the contents into the tub when the operation is finished.

The figure shows a spherical boiler, supported on hollow gudgeons, at which water and steam respectively are admitted.

Elevated faucets at the right hand admit the alkaline solution or water, respectively.

On the left are the steam valve and water-pipe, the latter for washing out the tub.

The process of boiling the paper material to make pulp, is for the purpose of disengaging the cellulose matter, and the details of the process, that is, the strength of the alkali, and the temperature and duration of the process, depend upon the character of the material under treatment, the object being to disengage the fiber, uninjured, from the cellulose and other matters which are associated with the fiber in the growing plant. The pectique principle which gives the parchment qualities which are found in some papers it is also desirable to preserve.

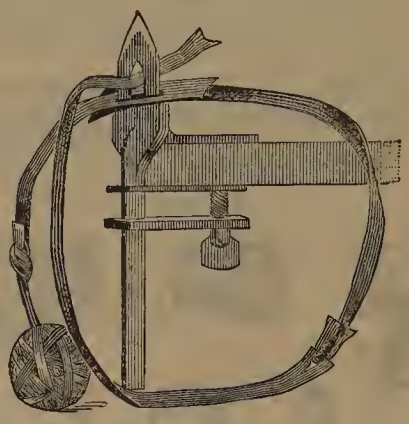
Rag Knife. (*Rag Engine.*) One of the knives in the cylindrical cutter, operating against those in the bed, or *bottom plate.* See Fig. 4112, p. 1856, "*Mech. Dict.*"

Rag Loop'er. Used in splicing rags for rag-carpet. It loops them together without sewing. Both ends are impaled on the perforated knife and the end of the last attached piece rove through the hole in the knife and pulled taut. The knife is raised and as its lower end is a pair of prongs it allows the knotted strip to slip off. See Fig. 2083.

Rag Pick'er. A shoddy machine for pulling to shreds woolen rags, stocking clip, hosiery, yarn, wool waste, old carpet, etc., and reducing them to cotton or wool staple, as the case may be.

The material is fed from the table between a pair of rollers to the cylinder; this is 16½″ wide.

Fig. 2083.

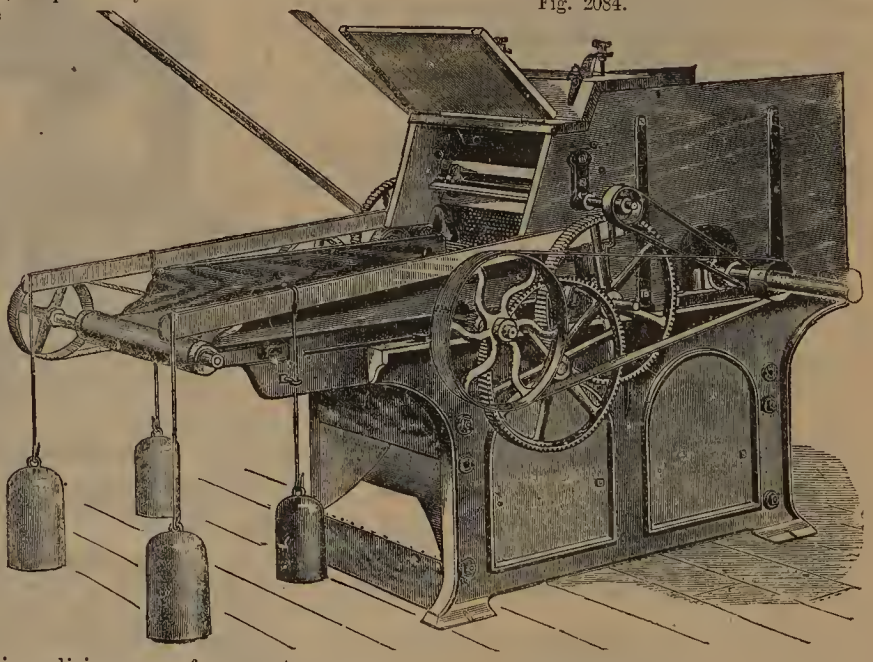


Rag Looper.

The face of the teeth is of steel and they are set in lags on the cylinder. The pressure on the feed rollers is adjusted by slipping the weights out or in upon the levers. The capacity is from 200 to 800 pounds per day, according to size. A lumping attachment throws out lumps and knots from the shoddy. See Fig. 2084.

Rag Wash'er. A form of apparatus like the pulping machine in form and action, but differing from it in this, that, instead of having on the cylinder knives acting as shears against the blades of the concave beneath to cut the rags into fine shreds and eventually into pulp, the rag washer has a

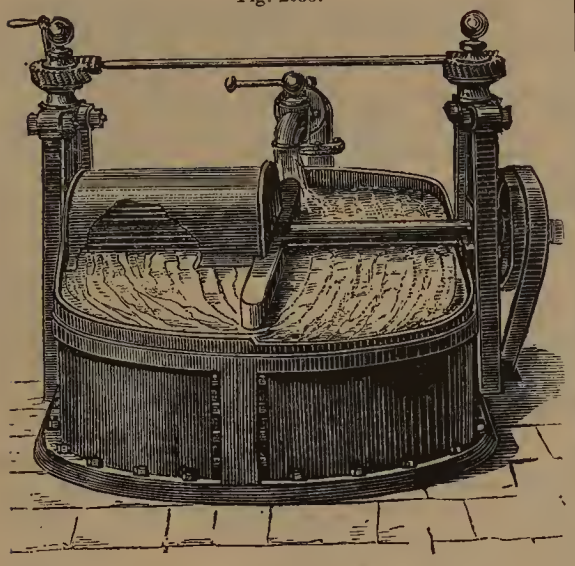
Fig. 2084.



Rag Picker.

cylinder with wooden or bronze bars which merely rub the material against a plate beneath, serving to disengage any dirt and traces of the coloring matters or salts incident to the material or the remains of processes through which it has previously passed. In the center is the water supply; on the left the cylinder case; above is the gearing by which the cylinder shaft is raised or lowered so as to adjust its position vertically. See Fig. 2085.

Fig. 2085.



Rag Washer.

Rag Wheel. (*Add.*) A polishing wheel made of disks of rags, rove upon a mandrel and clamped thereon. Such a wheel is from 4″ to 8″ diameter and runs at a speed of 7,000 per minute.

For use on iron: use a polishing material of equal parts of Vienna lime, crocus, and beeswax.

Boil these together, cool, cut into cakes. Dip a cake in oil and apply to the rag wheel occasionally.

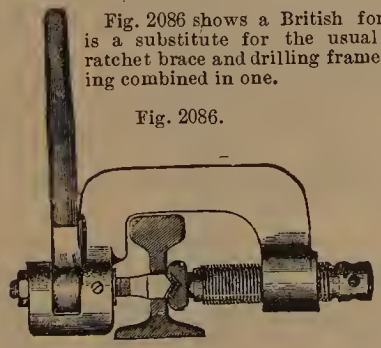
For brass, take crocus 2, wax 1, rouge ½; melt, mix, and apply as in the former case.

For nickel, use rouge with water or oil.

Rail Bor'er. A hand machine for boring the webs of rails for the passage of the bolts of fish-bars.

Fig. 2086 shows a British form which is a substitute for the usual separate ratchet brace and drilling frame, both being combined in one.

Fig. 2086.



Rail Borer.

Rail Key. (*Railway.*) A wedge-piece driven in between the rail and its chair.

Rail Ma-chin'er-y. Machines for rolling, bending, straightening, drilling, etc., railway rails.

See the following references: —

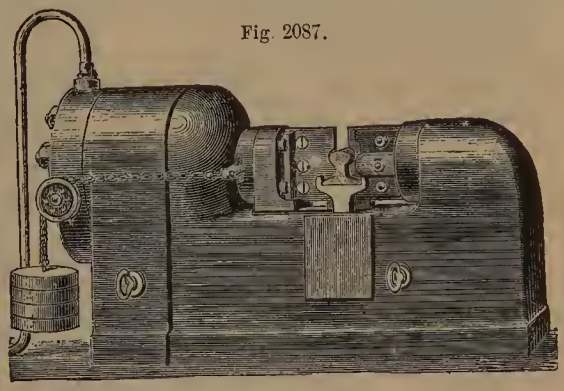
Rail-bending machine.	"*Van Nostrand's Mag.*," xxi. 260.
Schrabetz	"*Iron Age*," xxii., July 4, p. 19.
Rail drilling machine.	* "*Engineering*," xxv. 383.
Beland	* "*Engineer*," xlix. 412.
Rail-paring machine.	
Landore Siemens Steel Works	* "*Engineer*," xlii. 25.
Rail saw, *Kitson*, Engl. .	* "*Scientific American*," xxxv. 134.
Slitter	* "*Iron Age*," xviii., Nov. 2, p. 1.
Rail straitener, *Chisholm*	* "*Scientific American Sup.*," 834.
Wear-impl. for measur.	* "*Railroad Gazette*," xxiii. 126, 305.
Rail mill, Joliet Iron & Steel Co.	* "*Iron Age*," xvii., Jan. 6, p. 1.
Phila. & Reading Ry.	* "*Engineering*," xxv. 147.
Rails, rapid rolling . .	"*Scientific American*," xxxiv. 21.

See also ROLLING MILL.

Rail Shears. An application by Tweddel of the hydraulic power to cutting or squaring off the ends of rails.

It has one stationary and one movable abutment, the faces of which conform to the shape of the rail to be cut. It is used without the accumulator, which is usual with riveters, the complete plant consisting of a boiler, ram, and

Fig. 2087.



Tweddell's Rail Shears.

shears. The ram has a steam cylinder of relatively large diameter, the total pressure on which is imparted to a plunger of small diameter, producing a corresponding pressure on the water in the hydraulic cyliuder. The machinery is entirely coutrolled by steam valves.

Automatic cut-off gear is fitted to the steam cylinder so as to allow for expansion of the steam. This is effected by opening the tap at the point of cut-off required, and when the piston has passed the opening, the steam escapes through the tap, and closes a specially constructed throttle valve in the steam-inlet passage.

Rail'way. History and development, pp. 1860 *et seq.*, "*Mech. Dict.*"

See also the following references: —

Railways in China . .	* "*Scientific American Sup.*," 710.
In Japan	* "*Sc. American Sup.*," 691, 695.
Peruvian, Meiggs . . .	* "*Sc. American Sup.*," 1311, 1329.
Rigi, Lucerne	* "*Scientific American Sup.*," 3897.
In U. S., early	"*Iron Age*," xx., Oct. 18, p. 9.
In U. S., 1877.	"*Scientific American*," xxxvi. 89.
Vera Cruz, Mexico . .	"*Scientific American Sup.*," 896.
Vesuvius	"*Iron Age*," xxii., Oct. 17, p. 7.
	"*Sc. Am.*," xxxix. 327; xlii. 281, 309, 393.
	* "*Sc. Am. Sup.*," 3735, 3755, 3819.
Wetli mountain, Switz.	* "*Scientific Amer.*," xxxvi. 114.
Railways of the world. *Stuermer*	"*Scientific American Sup.*," 421.
Railway appliances at Phila., 1876, *Galton* .	"*Scientific American Sup.*," 1988.
Car, bullet proof . . .	"*Iron Age*," xix., May 3, p. 11.
	"*Scientific American*," xxxvii. 37.
Cost of	"*Scientific American*," xli. 209.
Derrick, *Voruz*, Paris, 1878	"*Scientific American Sup.*," 1989.
Subst. for hand car. *Noble*	"*Scientific American*," xxxv. 79.
Hitching while in motion, *Hanrez* . . .	* "*Scientific American Sup.*," 4073.
Irou, *Kellogg & Seaver*	"*Min. & Sc. Press*," xxxviii. 163.
	"*Scientific American Sup.*," 895.
Lighting	"*Scientific American Sup.*," 1811.
Metallic	"*Scientific American Sup.*," 772.
Sliding, Cox	* "*Scientific American*," xliii. 70.
Spring propelled. *Leveaux*	* "*Scientific American Sup.*," 740.
Steel	* "*Scientific American Sup.*," 596.
Street	* "*Scientific American Sup.*," 598.
	"*Scientific American Sup.*," 513.
Two-story, Br. . . .	* "*Engineering*," xxi. 104.
Velocipede	"*Scientific Amer.*," xxxviii. 101.
	* "*Scientific American Sup.*," 2825.

See Report on Railway Apparatus, Paris, 1878, by William A. Anderson; describes the Continental system of way and rolling stock. See "*Paris Exposition* (1878) *Reports*," vol. iv., p. 419, *et seq.* It contains the following illustrations: —

	Page.
First-class passenger car; Western Railway of France	446
Austrian first-class passenger car	448
Austrian second-class passenger car	448
Austrian third-class passenger car	448
Austrian freight car	448
Sleeping car; Austrian State Railway . . .	448
Decauville's tramway car	458, 459

Crossing, *Carey* . . . * "*Scientific American*," xliii. 215.
Early in U. S. . . . . "*Scientific Amer.*," xxxvii. 213.
Elevated, N. Y. . . . "*Scientific American Sup.*," 2018.
Field and military.
Fell, Engl. . . . . "*Scientific American Sup.*," 865.
Inspec. train, Penn. Ry. * "*Railroad Gazette*," xxi. 47.
Interlocking signals and switches, *Buel* . . . * "*Railroad Gazette*," viii. 64, 107.
Rail joint, *Acaster*, Engl. * "*Scientific American Sup.*," 1988.
* "*Railroad Gazette*," xxi. 371.
Mead . . . . . * "*Scientific American*," xxxiv. 22.
Nicholl . . . . . * "*Sc. American*," xxxvi, 358.
Robinson . . . . . * "*Railroad Gazette*," viii. 43.
Sandberg, Br. . . . * "*Engineer*," xlii. 325, 328, 340.
Rail lock, *Turl* . . . * "*Scientific American*," xli. 118.
Locomotive. See list on pp. 556–558, *supra*.
Railway, military, *Fell* . "*Van Nostrand's Mag.*," xvi. 90.
India . . . . . "*Iron Age*," xvii. Jan. 20, p. 3.
Haddan, Engl. . . . "*Scientific American Sup.*," 2084.
Pioneer or military.
Haddan, Eng. . . . * "*Scientific American Sup.*," 2239.
10-inch Gage . . . . "*Scientific American Sup.*," 1668.
Iron, Permanent way.
Wood . . . . . * "*Engineering*," xxv. 269.
Barlow, *
Wood, *
Potel, *
Hohenegger, *
MacLellan, *
Thoumen, *
C. I. Borel Sleeper.
Serres & Battie.
Hilf.
Hill . . . . . "*Iron Age*," xxxiii., Feb. 13, p. 9.
Seaton, Br. . . . . * "*Engineering*," xxiii. 275.
Harvey & Roe, Br. . . * "*Engineering*," xxiii. 98.
Newman . . . . . * "*Engineering*," xxiii. 136.
Livedey . . . . . * "*Engineering*," xxiii. 164.
Speilemann, Br. . . . * "*Engineering*," xxvi. 242.
Thomas, Br. . . . . * "*Engineering*," xxiv. 135.
Trevis iron, Br. . . * '*Engineer*,' l. 183.
Wood, iron, Br. . . * "*Engineering*," xxviii. 273.
Wood, iron, 10 Figs., Br. . . . . * "*Engineer*," xlv. 235.
Pilot, Penn. Ry. . . . * "*Engineering*," xxiv. 86.
Portable, *Bass* . . . . * "*Manuf. & Builder*," viii. 32.
Greig . . . . . "*Iron Age*," xxiv., July 31, p. 1.
Pioneer Works . . . . * '*Iron Age*," xix., May 17, p. 1.
Rack railings . . . . "*Van Nostrand's Mag.*," xxii. 9.
Locomotives, Switz. . . * "*Engineering*," xxiii. 413.
Agudio . . . . . "*Van Nostr. Mag.*," xxiii. 230.
Rail compound, *Clark* . "*Iron Age*," xviii., Oct. 19, p. 9.
Rails, wear of . . . . * "*Railroad Gazette*," xxi. 121.
Tests of, *Dudley* . . * "*Railroad Gazette*," xxiii. 26.
Rail sections, standard, *Sandberg* . . . . . * "*Railroad Gazette*," xxiv. 327.
Fish plate, etc., standard * "*Railroad Gazette*," xxiii. 643.
Rail, Sutton . . . . * "*Scientific American*," xxxv. 35.
Vaughn . . . . . * "*Scientific American*," xlii. 296.
Life of steel rails.
Williams . . . . . "*Scientific American Sup.*," 517.
Railway resistances.
Shinez & Dudley . . "*Scientific American Sup.*," 541.
Rolling stock, *Paris, Lyons & Med. Ry.* * "*Engineering*," xxvii. 46.
Penn Railway . . . * "*Engineering*," xxiv. 338.
Single Rail, Stone . . * "*Scientific American Sup.*," 511.
Single track . . . . "*Scientific American*," xxxv. 402.
Speed . . . . . "*Sc. Amer.*," xxxiv. 354, 393, 408; xxxv. 340.
N. Y. & Phila . . . . "*Sc. American*," xxxix. 180.
England . . . . . "*Scientific American*," xliii. 117.
"*Scientific American Sup.*," 436.
Splice . . . . . * "*Railroad Gazette*," xxii. 410.
Standard section.
Sandberg . . . . . * "*Engineering*," xxv. 277.
Raising a railway station.
Chepstow, Engl. . . . "*Scientific American Sup.*," 1668.
Rail for streets.
Aldred & Spielmann . "*Engineer*," xlvi. 223.
Beloe, Br. . . . . * "*Engineer*," xlvi. 315.
Edge, Br. . . . . * "*Engineer*," xlvi. 341.
Railway, street, *Aldred & Spielmann*, Br. . * "*Engineer*," xlvi. 21.
Vignoles, Br. . . . * "*Engineering*," xxvii. 265.
Switch, *Carey* . . . . * "*Scientific American*," xliii. 214.
Railway Term ("Northern" & France). . . * "*Scientific American Sup.*," 631.
Ties, iron . . . . . * *Blake's* "*Report Vienna Exp.*," iv. 66, 67.
"*Iron Age*," xxi., Jan. 31, p. 20.
"*Iron Age*," xix., April 19, p. 1.
Preserving . . . . "*Scientific American Sup.*," 1146.
Reese . . . . . * "*Scientific American*," xli. 83.
Iron, *Schofield* . . . * "*Scientific American*," xliii. 101.
Travis . . . . . * "*Iron Age*," xxiii., March 6, p 1
Iron *vs.* wood, *Weyers* "*Van Nostrand's Mag.*," xvii 525.
Wood . . . . . * "*Scientific American Sup.*," 1986.
Track, *Hall* . . . . . * "*Scientific American*," xl. 98.
Foster . . . . . * "*Am. R. R. Journal*," lii. 591.
Track sweeper, *Olmstead* "*Railroad Gazette*," xxi. 397.
Underground, London . "*Scientific American Sup.*," 1793.
Extension of London . * "*Sc. American Sup.*," 853, 886.
Underground, Paris . . "*Scientific American Sup.*," 1971.
Water . . . . . * "*Scientific American Sup.*," 758.
Wheels, cast iron . . . "*Scientific American Sup.*," 490.

The *Vesuvian Railway* has the double-rope system, a car traversing on each line of rails, one descending as the other ascends, mutually counterbalancing. Each carriage has two compartments each capable of holding 6 persons. The depot and engine are at the bottom, and at an elevation of 810 meters above the sea, and 210 meters above the observatory. A carriage drive leads from the observatory to the railway. The angles of inclination are respectively 40, 63, and 50 in a hundred, at different parts of the ascent. The road is 800 meters long and terminates some distance short of the crater. The ascent is made in 7 minutes.

Railway Elevations. — A British journal gives the following as the highest elevations above the level of the sea, attained by any point on the railways named: —

	Meters.
Apennine line	617
Black forest line	850
Sömmering line	890
Caucasus	975
St. Gothard tunnel	1,154
Bremmer line	1,367
Mt. Cenis line	1,338
Northern Pacific	1,652
Central Pacific	2,140
Union Pacific	2,513
Andes line	4,769

Railway Speed. — The following rates of regular train speed are given in the journals (fractions omitted): —

BRITISH.

"Flying Dutchman," Great Western Railway, London to Exeter, 194 miles, with 4 stops, 4 hours 14 minutes; 46 miles per hour.

"Leeds Express," Great Northern Railway, London to Leeds, 187 miles, with 4 stops, 4 hours; 47 miles per hour.

"Morning Express," Great Northern Railway, London to Edinburg, 395 miles, 9 hours; 44 miles per hour.

"Irish Mail," London and North Western Railway, 40 miles per hour.

"Scotch Express," Midland Railway, London to Glasgow, 425 miles; 40 miles per hour.

UNITED STATES.

"Boston and New York Express," Boston and Albany Railroad, 234 miles, 6 hours, 12 stops; 37 miles per hour.

"San Francisco Express," Jersey City to San Francisco, (ending June 4, 1876), 83 hours; 34 miles per hour. Jersey City to Pittsburg, 444 miles, 10 hours.

See also LOCOMOTIVE, pp. 555, 556, *supra*.

AVERAGE EXPRESS RATES.

	Per hour.
Paris & Marseilles Express	66.3 kilometers.
Berlin & Cologne (Lelviter line)	60. kilometers.
Spandan & Stendal (Lelviter line)	71.8 kilometers.
Berlin & Magdeburg (Potsdam liue)	67.9 kilometers.
Brandenburg & Magdeburg (Potsdam linc)	69.15 kilometers.
Great Western, Br.	53½ miles.
Great Northern, Br.	51 miles.
London & Brighton, Br.	47½ miles.
London & Northwestern, Br.	47½ miles.
Midland, Br.	46 miles.
London, Chatham & Dover, Br.	45 miles.
Southeastern, Br.	45 miles.
Great Eastern, Br.	44 miles.
London & Southwestern, Br.	44 miles.

Refer to "*Van Nostrand's Mag.*," xxi. 439.
"*Scientific American*," xli. 115, 119, 266, 277.
"*Sc. American Sup.*," 3820, 3821.

Rail'way Ap'pa-ra'tus, Run'ning Stock, and Parts. See under the following heads: —

Air brake.
Air cylinder.
Air gage.
Air pump.
Air strainer.
Anthracite furnace.

Ash pan.
Atmospheric brake.
Automatic air-brake.
Automatic car-brake.
Automatic ventilator.
Axle.
Axle box.
Axle box guides.
Axle collar.
Axle frame.
Axle packing.
Axle seat.
Axle stop-key.
Back-truck locomotive.
Baggage car.
Basket rack.
Bathing car.
Bell cord.
Bell ringer.
Bell rope.
Bell strap.
Block signal system.
Block system.
Boarding car.
Bob-tail car.
Bogie.
Boiler.
Bolster spring.
Bonnet.
Box car.
Box cattle car
Box packing.
Brake.
Brake beam.
Brake cylinder.
Brake hose.
Brake hose coupling valve.
Brake lever.
Brake pipe.
Brake rod.
Brake rubber.
Brake shoe.
Brake shoe valve.
Break-down van.
Broad-tread wheel.
Buffer.
Cab.
Cabin car.
Cable carrier.
Cannon car.
Car.
Car axle.
Car brake.
Car coupler.
Car-door hanger.
Car heater.
Car load.
Car platform.
Car pusher.
Car runner.
Car seal
Car signal.
Car spring.
Car transfer truck.
Car truck.
Car truck shifter.
Car unloading plow.
Car ventilator.
Car washing machine.
Car wheel.
Cattle car.
Center bearing.
Center draft draw bar.
Center pin.
Center plate.
Centripetal railway.
Chafing plate.
Check chain.
Check valve.
Cleaning hole.
Clear story
Clip chair.
Cluster spring.
Clutch coupling.
Coach.
Coal car.
Coal-dust-burning locomotive.
Combination spring.
Combined car.
Compound locomotive.
Compound spring.
Compressed air brake.
Compressed air locomotive.
Compressed air rail-car.
Compromise wheel.
Conductor's car.
Conductor's valve.
Consolidation locomotive.
Continuous brake.
Couplet.
Coupling.
Coupling bar.
Coupling case.
Coupling chain.
Coupling hook.
Coupling hose.
Coupling link.
Coupling pin.
Coupling valve.
Cradle.
Crank pin.
Cremating car.
Cross-head.
Cross-tie.
Crown arch.
Crown bar.
Cushioned axle.
Cylinder.
Cylinder car.
Dash-guard.
Dead-blocks.
Dead-lock.
Dead weight.
Derrick car.
Diamond truck.
Door apron.
Door guard.
Door strap.
Double-coil spring.
Double-deck car.
Double-ender locomotive.
Double-plate wheel.
Double-truck locomotive.
Draw-bar.
Draw-clevis.
Draw-gear.
Draw-hook.
Drawing-room car.
Draw-rod.
Draw-spring.
Drilling.
Driver brake.
Driving-wheel.
Driving-wheel brake.
Drop-and-transfer table.
Drop bottom.
Dummy car.
Dump car.
Dumping wagon.
Dust collar.
Dust guard.
Edge-rolled spring.
Ejector.
Elastic wheel.
Elder brake.
Electric railway.
Elevated railway.
Equal-bar nest spring.
Equalizing bar.
Equipment.
Exhaust nozzle.
Express car.
Face plate.
Faggoted axle.
Feed.
Fender board.
Ferry push-car.
Finish.
Fireless locomotive.
First-class car.
Flat bar spiral spring.
Flat car.
Flexible wheel-base.
Floating lever.
Flume car.
Fourway cock.
Frame.
Freight car.
Freight truck.
Front rail.
Furnace.
Furniture.
Gage.
Geared locomotive.
Gondola car.
Graduated spring.
Grain car.
Grain door.
Grate.
Grated door.
Gravel car.
Grease box.
Group spring.
Guide.
Guide yoke.
Gum spring.
Half-round-bar spiral spring.
Hand car.
Hand strap.
Hand wheel.
Hauling engine.
Hay car.
Head light.
Head lining.
Heater cock
Helper ring.
Hibbard spring.
Hodge brake.
Hollow spoke wheel.
Hood.
Horn block.
Horns.
Horse car.
Hotel car.
House car.
Housing box.
Hub bolt.
Hydraulic railway brake.
Ice car.
Inclined-plane car.
Independent car-wheel.
Independent track.
India-rubber spring.
Injector.
Inner-hung brake.
Inspection car.
Intermediate floor.
Iron wheel.
Janney coupler.
Jet valve.
Joint splice.
Journal bearing key.
Journal box.
Journal box cover.
Journal packing.
Journal spring.
Key-shaped spiral spring.
King-bolt plate.
Lamp jack.
Lazy cock.
Leaden seal.
Leakage valve.
Lever hand-car.
Life.
Locomotive.
Locomotive crane.
Locomotive cup.
Lodging car.
Log railway.
Mail car.
Mail catcher.
Main frame.
Milk car.
Mine car.
Mine car wheel.
Mine locomotive.
Mogul locomotive.
Monitor car.
Muley axle.
Multicoil spring.
Narrow gage.
Narrow gage locomotive.
Nest spring.
Oil box.
Oil car.
Oil cellar.
One-legged railway.
One-rail railway.
Open-plate wheel.
Ore car.
Outer hung brake.
Paper wheel.
Passenger car.
Pedestal.
Permanent way.
Petticoat pipe.
Pilot.
Piston.
Plate wheel.
Platform.
Pneumatic dispatch.
Pneumatic tube.
Pneumatic tubular dispatch.
Pole railway.
Pony tank-locomotive.
Portable railway.
Portable-road locomotive.
Post-office car.
Prismoidal rail.
Pull iron.
Push car.
Quadruple-coil spring.
Quadruplet.
Quieting chamber.
Quieting nozzle.
Quintuplet.
Rack car.
Rack railway.
Radial axle box.
Rail.
Rail chair.
Rail key.
Rail splice.
Railway.
Railway brake.
Railway car.
Railway car brake.
Railway crossing.
Railway gage.
Railway gate.
Railway signal.
Railway speed.
Railway switch.
Railway tie.
Railway track bolt.
Railway velocipede.
Raised roof.
Reducing valve.
Refrigerating car.
Releasing lever.
Restaurant car.
Retaining ring.
Reversible seat.
Reversible street-car.
Reversing cylinder.
Road locomotive.
Rocker.
Rod.
Roof-apron.
Roofing canvas.
Roof light.
Roof step.
Round-bar spiral spring.
Rubber spring.
Rubber-center spiral spring.
Rubber-center spring.
Running board.
Safety chain.
Safety hanger.
Safety link.
Sand brake.
Seal hook.
Seal lock.
Seal press.
Seal wire.
Seat lock.
Ship railway.
Shunt.
Shunting engine.
Side bearing.
Single-coil spring.
Single-plate car-wheel.
Single-plate street-car wheel.
Single-rail railway.
Slack-burning locomotive.
Sleeper.
Sleeping car.
Sliding-door lock.
Smoke-stack.
Snow flanger.
Snow plow.
Snow scraper.
Spark arrester.
Spark ejector.
Spark netting.
Spiral spring.
Splice joint.
Spoke wheel.
Spool-shaped spiral spring.
Spring.
Spring-beam.
Spring block.
Spring case.
Spring plank.
Spring saddle.
Spring stud.
Square-bar spiral spring.
Stake.
Stake hook.

Stake pocket.
Stake rest.
Stake sleeve.
Stanchion.
Standard gage.
Starting valve.
Steam gong.
Steam sled.
Steam street-car.
Steam valve.
Steeled wheel.
Steel-tired car-wheel.
Steel wheel.
Stock car.
Stop plate.
Stove-pipe jack.
Stove-pipe ring.
Street-car.
Street-car locomotive.
Swing-motion gear.
Switch.
Switch chair.
Switching eye.
Tail lamp.
Tandem engine.
Tank.
Tank car.
Tank dome.
Tank locomotive.
Telescopic tank car.
Tender.
Tender hose.
Tie.
Tip car.
Tire.
Tool box.
Tool car.
Towing.
Towing locomotive.
Track bolt.
Track laying machine.
Track laying tools.
Track lifter.
Track sweeper.
Traction engine.
Trailing-tank locomotive.
Train brake.
Train car.
Tramway.
Tramway locomotive.
Transfer table.
Traverser.
Triple-coil spring.
Triplet.
Triplet spring.
Triple valve.
Truck.
Truck bolster.
Truck frame.
Truck side bearing.
Tube.
Turntable.
Twin locomotive.
Undergear.
Underground railway.
Vacuum brake.
Valve motion.
Ventilator deflector.
Ventilator hood.
Volute spring.
Waist.
Warming valve.
Washburn wheel.
Washer.
Water crane.
Water supply for locomotives.
Way.
Wheel.
Wheel box.
Wheel center.
Wheel flange.
Wheel flange lubricator.
Wheel plate.
Wheel rib.
Wheel seat.
Wheel tread.
Whistle.
Wicket.
Wide gage.
Window opener.
Wire rope conveyor.
Wire tramway.
Wooden rail.
Wool-packed spiral spring.
Wrought-iron wheel.

Rail'way Bridge. See BRIDGE, *supra*, pp. 132–134, where are numerous references to railway bridges in different parts of the world, and tables of relative dimensions.

See also list under BRIDGE, "*Mech. Dict.*"

See also the following refereuees: —

Howe, Ashtabula . .	* "*Scientific American Sup.*," 895.
Blackwell's Isl., E. River	* "*Scientific American Sup.*," 1876.
Lay span, paper by *T. C. Clark*	"*Scientific American Sup.*," 2095.
Key, River	* "*Scientific American Sup.*," 1044.
Louisville	* "*Scientific American Sup.*," 866.
Poughkeepsie	* "*Scientific American Sup.*," 1043.
	"*Scientific American Sup.*," 1794.
Sarpsfos, Norway, *C. Phil*	* "*Scientific American Sup.*," 1934.
Tay, Tests of . . .	"*Scientific American Sup.*," 1877.
Tay, Scotland	* "*Scientific American Sup.*," 1042.
River Tay	* "*Scientific American Sup.*," 2107.

Rail'way Car Brake. A means for bringing friction upon the wheels of a car to restrain rotation and slacken the speed of or stop the train. The subject is considered under AIR BRAKE; CAR BRAKE; PNEUMATIC BRAKE; etc., "*Mech. Dict.*" See references under RAILWAY BRAKE, p. 1862. *Ibid.*

The Westinghouse automatic brake is shown in Plates XLI., XLII., which, taken together, illustrate the consecutive portions of the apparatus, The plates also show side and end elevations of a locomotive with apparatus attached, and a view of the under side of a part of a locomotive and tender, similarly furnished.

The *Westinghouse* automatic brake consists of the following essential parts: —

The steam engine and air-pump, which produce the compressed air. These are shown to the right hand in Plate XLII., the steam engine above and the air-pump below; the pistons and rods in line.

The main reservoir, in which the compressed air is stored.

The engineer's brake-valve, which regulates the flow of air from the main reservoir into the brake-pipe for releasing the brakes, and from the brake-pipe to the atmosphere for applying the brakes.

The main brake-pipe, which leads from the main reservoir to the engineer's brake-valve, and thence along the train, supplying the apparatus on each vehicle with air.

The auxiliary reservoir, which takes a supply of air from the main reservoir, through the brake-pipe, and stores it for use on its own vehicle.

The brake-cylinder, which has its piston-rod attached to the brake-levers in such a manner that, when the piston is forced out by air pressure, the brakes are applied.

The triple valve, which connects the brake-pipe to the auxiliary reservoir, and connects the latter to the brake-cylinder and is operated by a sudden variation of pressure in the brake-pipe, (1) so as to admit air from the auxiliary reservoir to the brake-cylinder, which applies the brakes, at the same time cutting off the communication from the brake-pipe to the auxiliary reservoir, or (2), to restore the supply from the brake-pipe to the auxiliary reservoir, at the same time letting the air in the brake-cylinder escape, which releases the brakes.

The couplings, which are attached to flexible hose, and connect the brake-pipe from one vehicle to another.

The automatic action of the brake is due to the construction of the triple valve, the primary parts of which are a piston and a slide-valve. A reduction of pressure in the brake-pipe causes the excess of pressure in the auxiliary reservoir to force the piston of the triple valve down, moving the slide-valve so as to allow the air in the auxiliary reservoir to pass directly into the brake-cylinder and apply the brakes. When the pressure in the brake-pipe is again increased above that in the auxiliary reservoir, the piston is forced up, moving the slide-valve to its former position, opening communication from the brake-pipe to the auxiliary reservoir, and permitting the air in the brake-cylinder to escape, thus releasing the brakes.

Thus it will be seen that any reduction of pressure in the brake-pipe applies the brakes, which is the essential feature of the automatic brake. If the engineer wishes to apply the brakes, he moves the handle of the engineer's brake-valve to the right, which first closes a valve retaining the pressure in the main reservoir, and then permits a portion of the air in the brake-pipe to escape. To release the brakes, he turns the handle to its former position, which allows the air in the main reservoir to flow into the brake-pipe, restoring the pressure and releasing the brakes. A valve, called the conductor's valve, is placed in each car, with a cord running the length of the car, and any of the train-men, by pulling this cord, can open the valve, which allows the air to escape from the brake-pipe. Should the train break in two, the air in the brake-pipe escapes, and the brakes are applied to both sections of the train; and should a hose or pipe burst, the brakes are also automatically applied.

The gage shows the pressure in the main reservoir and brake-pipe when they are connected, and the pressure in the brake-pipe alone when the main reservoir is shut off by the movement of the engineer's brake-valve.

A non-automatic brake cannot be made to work satisfactorily upon more than from 10 to 12 cars, while it is possible to work trains of 50 cars with the automatic brake without difficulty. With the non-automatic brake the air is stored upon the engine and transmitted back through the pipe, and consequently there is a loss of time both in putting on and taking off the brakes. With the automatic brake, the air is stored upon each car ready for use, and this supply is readily brought into action by a slight reduction of pressure in the main pipe, which reduction requires the movement of but a trifling quantity of air as compared with that used for setting a non-automatic brake.

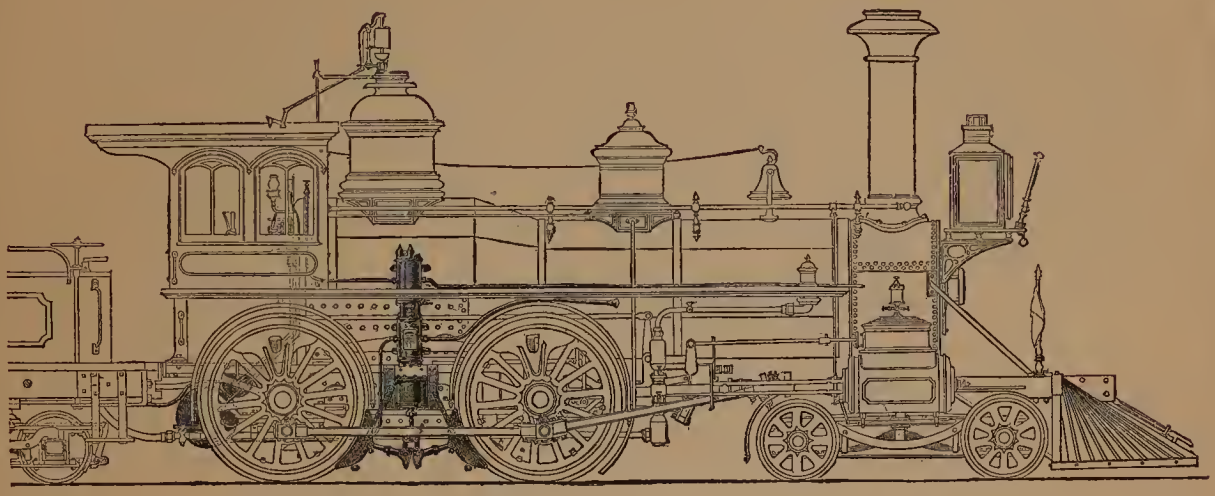
A modification of the automatic car brake adapts it specially to freight cars. The operation is the same, but the triple-valve, brake-cylinder, and reservoir are bolted together and avoid the pipe connections.

The following brakes are described and illustrated in Forney's "*Car-builder's Dictionary*."

Tyler, lever.	*Creamer*, lever.
Hodge, lever.	*Smith*, vacuum.
Stevens, lever.	*Eames*, vacuum.
Tanner, lever.	*Westinghouse*, automatic air-brake.

Capt. Douglas Galton's report, "*Centennial Exhibition Reports*," vol. vi., Group XVIII., p. 34, describes early devices and notices of continuous brakes: —

Westinghouse.	*Goodale.*
Henderson.	*Smith.*
Achard, electric, Fr. .	* "*Engineering*," xxiv. 395.
	* "*Telegraphic Journal*," vi. 327.
	"*Railroad Gazette*," xxiv. 590.
Barker, hydraulic, Gt.	* "*Engineer*," xlvii. 409.
Eastern Ry., Br. . .	* "*Telegraphic Journal*," vi. 301.
Beeker, automatic Austria	* "*Engineer*," xlv. 73.
	* "*Railroad Gazette*," xxii. 76.
Clark & Webb	"*Telegraphic Journal*," vi. 300.
Congdon, Brake shoe .	* "*Railroad Gazette*," xxi. 398.



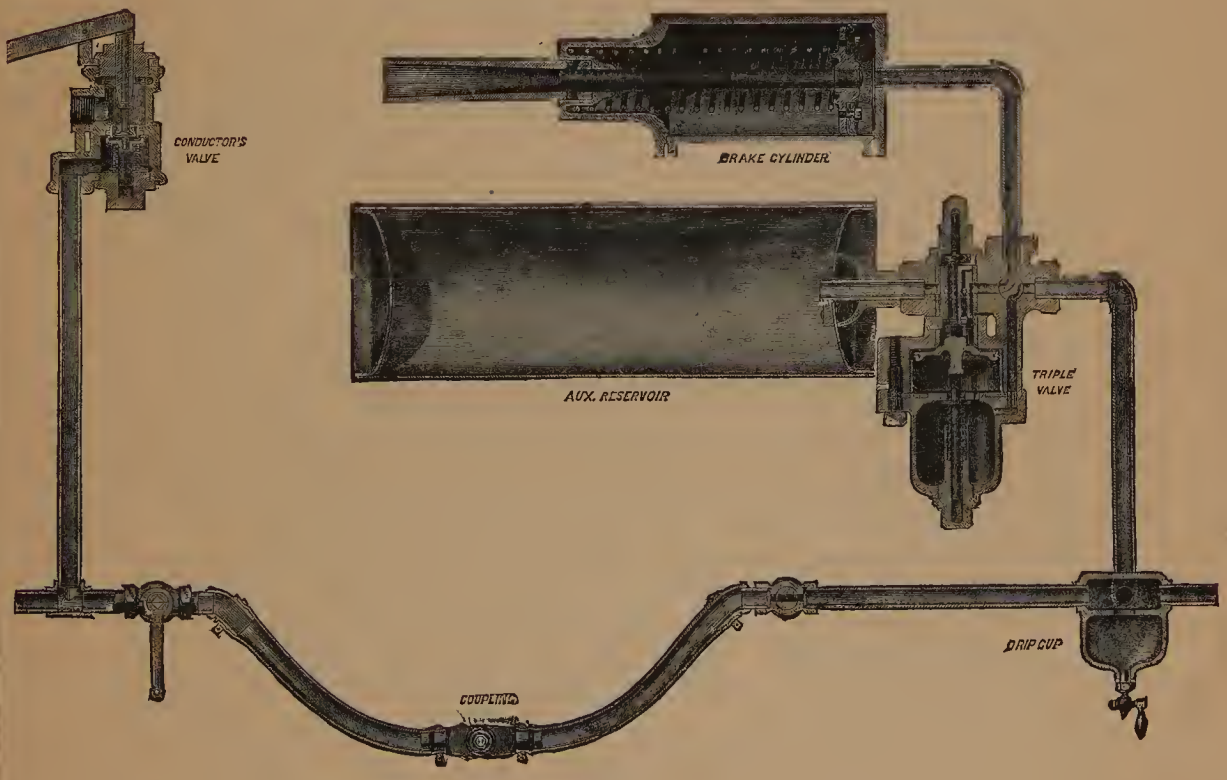
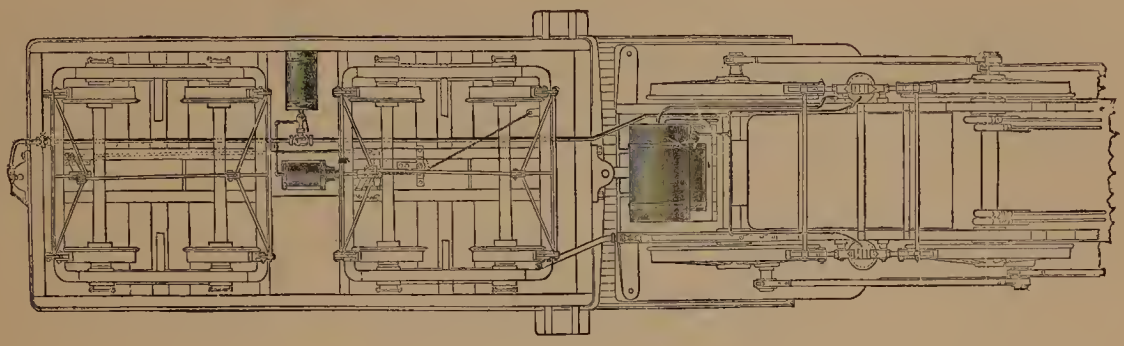
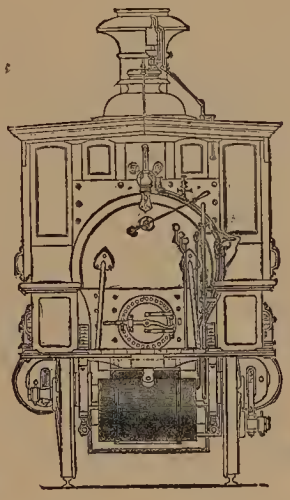
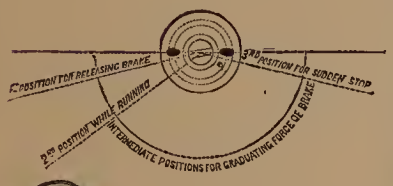
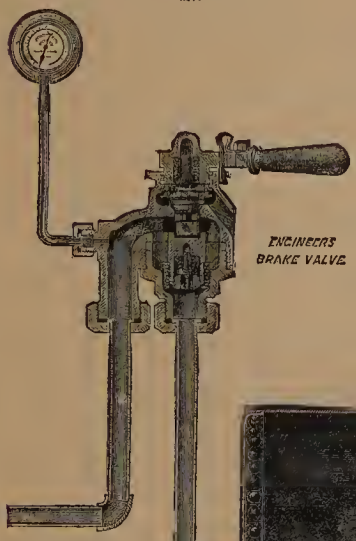


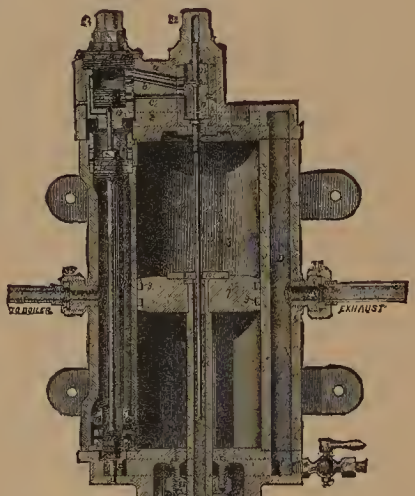
PLATE XLI. WESTINGHOUSE AUTOMATIC BRAKE. (CAR ATTACHMENTS.) *See page* 740.






1ST POSITION FOR RELEASING BRAKE
2ND POSITION WHILE RUNNING
INTERMEDIATE POSITIONS FOR GRADUATING FORCE OF BRAKE
3RD POSITION FOR SUDDEN STOP





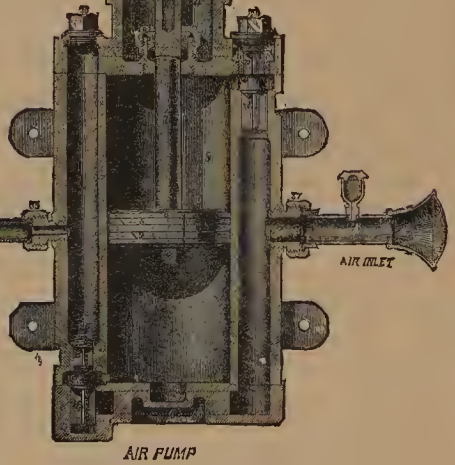


PLATE XLII. WESTINGHOUSE AUTOMATIC BRAKE. (LOCOMOTIVE ATTACHMENTS.) *See page* 740.

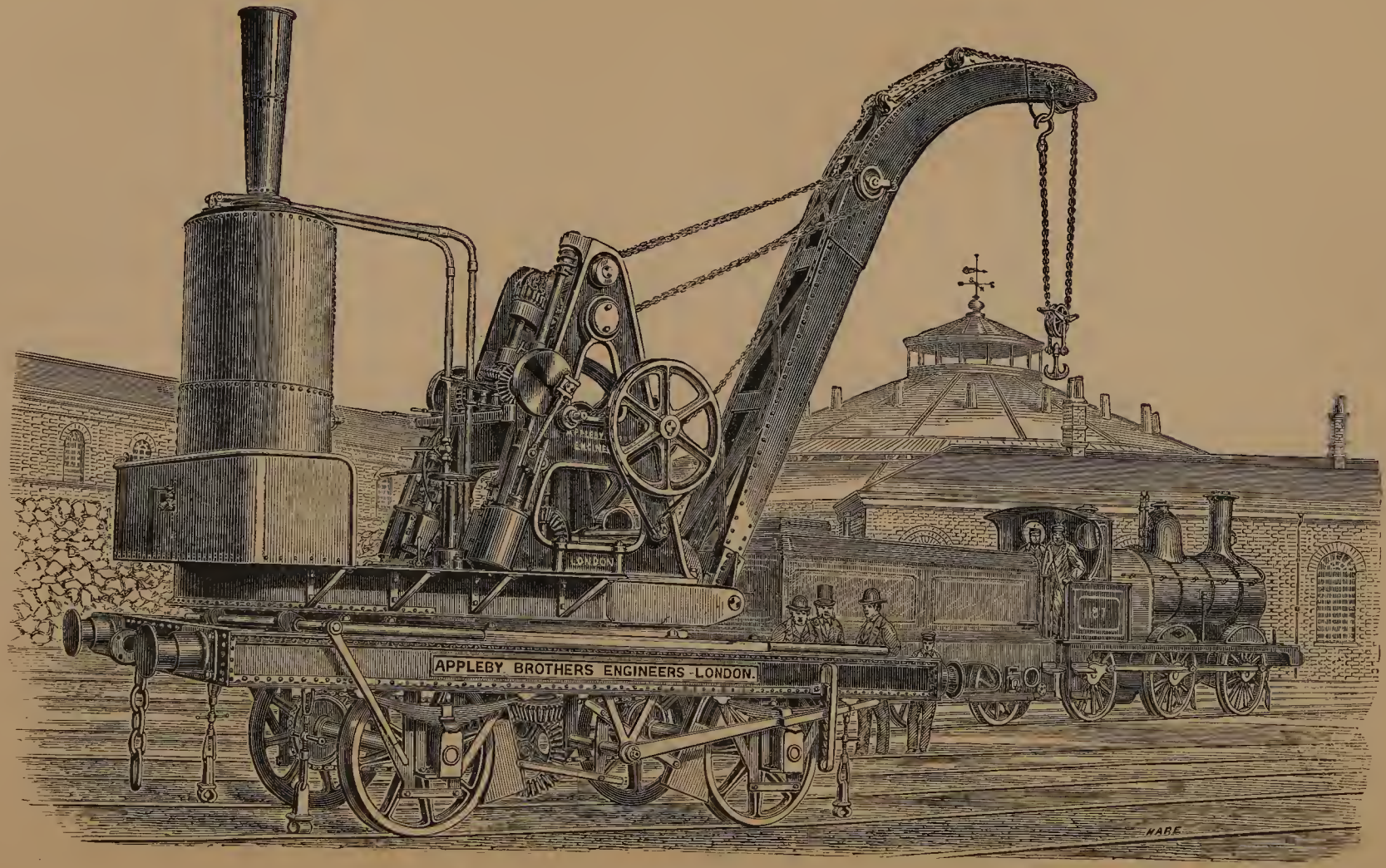


PLATE XLIII.

APPLEBY'S ENGLISH LOCOMOTIVE STEAM CRANE.

See page 741.

Conover, electric	"*Scientific American*," xlii. 294.
French, electro-mag.	* "*Scientific American Sup.*," 1760.
Guerin	* *Laboulaye*, i., "*Chemins de fer*," 144.
Hofeker	* "*Scientific American*," xxxv. 66.
James, automatic	* "*Scientific American*," xxxii. 22.
Lander	* "*Engineer*," xlii. 7.
Loughbridge	"*Scientific Amer.*," xxxiv. 289.
Sanders, vacuum	"*Telegraphic Journal*," vi. 301.
Shellhorn	* "*Scientific American*," xxxv. 258.
Smith, Br.	* "*Engineer*," l. 421.
	"*Scientific American*," xxxvii. 53.
	"*Telegraphic Journal*," vi. 282.
Thompson	"*Am. R. R. Journal*," xlix. 771.
Westinghouse	* "*Railroad Gazette*," viii. 159.
	"*Telegraphic Journal*," vi. 282.
	* "*Engineer*," xlviii. 65, 68.
	* "*Engineering*," xxvi. 422.
On Engl. R. R.	* "*Scientific American Sup.*," 1935.
	* "*Engineering*," xxii. 239.
N. E. Ry., Br.	* "*Engineering*," xxviii. 28, 55, 74.
Reducing Valve	* "*Engineering*," xxvii. 85.
Phila., 1876	* "*Scientific American Sup.*," 863.
On screw brake, * *Sanders*	"*Engineer*," xlv. 77.
Chain brake, *	
Vacuum brake, *	
Hydraulic brake, *	
Compressed air brake, *	
Automatic vacuum, *	
French report on continuous brakes	* "*Scientific American Sup.*," 2270.
Trials, Br. report, tables	"*Engineering*," xxiii. 12, 94.
	"*Railroad Gazette*," xxi. 33.
Calculation, Engl.	"*Scientific American Sup.*," 555.

Rail'way Crane. A crane adapted to travel on a railway track; either as a wrecking crane, or for loading and unloading purposes. Such are also used in building sea-walls, depositing blocks of concrete in advance of the track, which is laid piecemeal as the foundation advances.

The crane shown in Plate XLIII. is made by Appleby, of London. It is mouuted on a permanent way truck with buffers and springs, aud has a curved wrought iron jib, and a boiler acting as a counterpoise. It carries a load of 5 tons. It is self-propelling, or the traveling motion can be thrown out of gear, and the crane, being securely locked, can be attached to a train for traveling to any part of the line where its services are required. The cylinders are fitted with link reversing gear, and the several motions are transmitted from the engine shaft; there are four speeds of lifting, aud the load can be lowered either by the brake or by reversing the engines; the turning motion is effected through double friction elutches, and suitable gear which drives a wide roller immediately under the jib, and this operation is performed in either direction, and simultaneously with any of the others, and being obtained entirely by the friction of surfaces instead of by toothed gear on the base-plate, the risk of breakage arising from stopping or starting too suddenly is avoided. The derrick motion for altering the radius is worked by worm gear and a pair of chains, one end of which is attached to the crane-frames, the other end coiling round the derrick barrel. The traveling motion is obtained by a shaft passing through the center of the crane post, and driven from the crank-shaft, the lower end of this vertical shaft giving motion to another shaft fixed horizontally under the craue-carriage, and in order to allow of the deflection of springs, the power is transmitted through pitch chaius from this shaft to both traveling axles. The crane is mounted on a wrought-iron carriage similar in all respects to the ordinary permanent-way stock. The jib is curved in order to give sufficient clearance for lifting large logs ou to trucks, for stacking timber, etc., or even to lift a disabled truck aud place it on a platform truck.

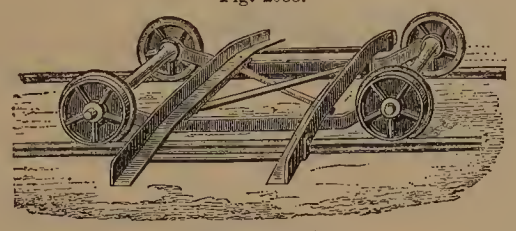
A very large and efficient form of crane of this descriptiou is shown at Fig. 5652, p. 2335, "*Mech. Dict.*" A smaller one at Fig. 5651, previous page. See also BALANCE CRANE, Fig. 176, p. 66, *supra*.

There are other forms of cranes which run ou rails in manufacturing establishments, machine shops, etc., the floorways of foundries, etc. See also OVERHEAD CRANE; TRAVELING CRANE, etc., "*Mech. Dict.*"

Rail'way Cros'sing. A temporary bridge for carriages across a line of rails. It consists of a pair of angle-irons arched so as to span the track. A somewhat similar device is the hose-bridge which allows street cars to cross fire hose laid across the rails. Fig. 2579, p. 1131, "*Mech. Dict.*"

The form shown in Fig. 2088 is the French transbordeur de wagonetts; the bridge plates are carried on a low truck so as to be transportable on the line of rails which they bridge.

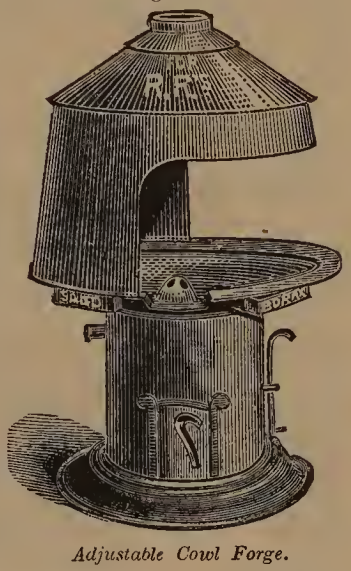
Fig. 2088.



Railway Crossing.

Rail'way Forge. A form of portable forge specifically adapted for work on railways, shown in Fig. 2089. It has a lantern bellows inclosed in the pillar and worked by a handle. The cowl is shiftable to windward to protect the fire.

Fig 2089.



Adjustable Cowl Forge.

Rail'way Plow. 1. A plow attached to a car or locomotive and used in excavating or ditching alongside the track. See references under PLOW.

2. A snow plow.

Rail'way Scale. A track scale for weighing cars in transitu. See *m*, Plate LXXIII, p. 2754, "*Mech. Dict.*"

Rail'way Sig'nal. The interlocking system of switches and signals is used in connection with switches at stations and junctions.

The block system is used to prevent more than one train from occupying a given space between stations at the same time. See BLOCK SYSTEM, p. 110, *supra*, and references *passim*.

See the following references: —

Car signal, Engl., *Stewart*	"*Scientific Amer.*," xxxiv. 164.
By train, audible	* "*Scientific American Sup.*," 647.
Audible, *Aird*, Br.	* "*Engineer*," xli. 69.
Brierly	* "*Railroad Gazette*," viii. 477.
Audible, *Brown*, Br.	* "*Engineer*," xlii. 112.
Interlocking signals and switches, *Buell*, on	* "*Railroad Gazette*," viii. 64, 107.
Automatic, *Hall*	* "*R. R. Gaz.*," xxiii. 563, 577, 589.
N. Ry. of France	* "*Railroad Gazette*," xxiii. 233.
Burns, Br.	* "*Engineer*," xlv. 128.
Robinson	* "*Scientific American*," xxxv. 66.
Saxby & Farmer, Br.	* "*Engineering*," xxv. 403.
	* "*Railroad Gazette*," viii. 341, 342, 443, 453.
	"*Engineering*," May 24, "1878."
Electric.	
Siemens & Halske	* "*Scientific American Sup.*," 1024.
Signal recorder, *Siemens*	* "*Telegraphic Journal*," vi. 90.
Electric, insulated track	* "*R. R. Gaz.*," xxiv. 141, 153, 163.
Electric repeaters for signals	"*Telegraphic Journal*," iv. 329.
Electric train in transitu	"*Van Nostrand's Mag.*," xv. 475.
By rails as conductors	"*Telegraphic Journal*," iv. 247.
Explosive	* "*Scientific American Sup.*," 191.
Locking apparatus.	
Saxby & Farmer, Br.	* "*Engineer*," xli. 87.
Switch signals, on, Br.	* "*Engineering*," xxii. 519.

See *Pope & Hendrickson's* pamphlet, "*Electric Railroad Signals*," Russell Bros., N. Y., 1875.

Rain'-wa-ter Stop. 1. A valve or chute to turn rain-water to a cistern or to waste, as may be required. In the latter case to allow the roof to be

washed before turning the water into the cistern. Fig. 1572, p. 667, "*Mech. Dict.*"

2. A three-way cock, as the divarication of a pipe which has branches leading to the cistern and well respectively.

Raised Roof. A clear-story car roof.

Rais'ing Ves'sels. See pp. 1874, 1875, "*Mech. Dict.*"

Air bags for, "*Engineering*"	"*Van Nostrand's Mag.*," xiv. 122.
"Edith,"	* "*Scientific American Sup.*," 1729.
Tassey	* "*Scientific American Sup.*," 690.
"Vanguard"	"*Scientific American Sup.*," 1089.

Rake. See HAY RAKE, *supra*, and Figs. 4152–4158, pp. 1876, 1877, "*Mech. Dict.*"

Ram. 1. (*Hydraulic.*) See page 1150, "*Mech. Dict.*"

Ram, hydraulic	* "*Eng. & Min. Jour.*," xxvi. 294.
Rams for rural water works, *Hett*, Br.	* "*Engineer*," l. 174.
Montgolfier, *Jones*	* "*Scientific American Sup.*," 2463.

2. (*Naval.*) See page 1878, "*Mech. Dict.*"

Ra'mie Ma-chin'e-ry. Machinery for decorticating and reducing the *rhea* fiber or China grass; better known by its Malay name, *ramie:* the *Bœhmeria nivea* of the botanists. It is the material of China-grass cloths. — *Falconer; Hooker.*

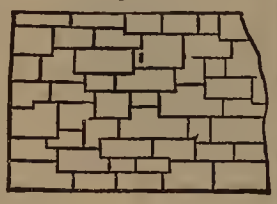
Shown in various stages of manufacture at the London Exhibition of 1851. See Report of Group VIII., "*Centennial Exhibition* (Phila.) *Reports*," 1876, pp. 4, 5.

Ramie mach., *Favier*	"*Technologiste*," xli. 76.
Leger	"*Technologiste*," xxxiv. 117.
Jute, *Lockert*	"*Technologiste*," xli. 171.
Ramie fibre	"*Scientific American Sup.*," 1483.
Machines, *Bouchard*	* "*Scientific Amer.*," xxxvii. 278.
Coleman	* "*Scientific Amer.*," xxxvii. 278.
Lefranc & Nagoua	* "*Scientific Amer.*," xxxvii. 278.
Bouchard	* "*Min. & Sc. Press*," xxxvi. 3.
	"*Sc. American*," xxxviii. 72.
Manufacture	"*Scientific American*," xl. 345.

See also RHEA FIBER.

Rand Breast'ing Ma-chine'. A guillotine knife operated by treadle to trim the front face or breast of heel rands. See RAND, page 1879, "*Mech. Dict.*"

Fig. 2090.



Random Stone Work.

Ran'dom Stone Work. (*Masonry.*) Flat stone not laid in courses; differing in this respect from RANGE WORK, which see.

Range Find'er. An instrument for measuring distances by sight.

See DISTANCE MEASURER, p. 262, *supra;* TELEMETER, Figs. 6255, 6256, pp. 2513, 2514, "*Mech. Dict.*"

On	"*Engineer*," xlii. 109.
	"*Scientific American*," xxxvii. 20.
	* "*Sc. American Sup.*," 884, 2777.
Berdan	* "*Engineer*," xlvii. 212.
	* "*Engineer*," xliii. 179.
Lieut. Edwards	"*Van Nostr. Mag.*," xxiii. 437.
Watkins	* "*Scientific American Sup.*," 1555.
	"*Scientific American*," xxxvi. 22.

See report on Range finders, "*Ordnance Report*," 1879, Appendix X., p. 373, *et seq.*, with 6 plates. Including

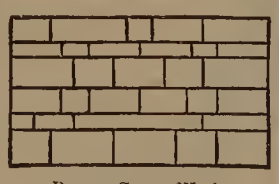
Watkins' range finder, p. 373, Plate I.

Berdan telemeter, p. 379, Plate II.

Berdan telemeter (improved) p. 384, Plate III.

Nolan's range finder, p. 385, Plates IV.–VI.

Fig. 2091.



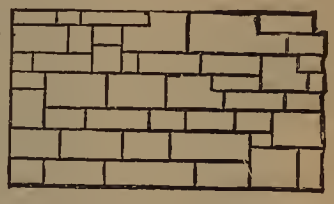
Range Stone Work.

Range Stone Work. (*Masonry.*) Stone work laid in courses.

Range Work may have courses of different thicknesses, but the level joint is preserved.

In *Broken range work* the uniformity is occasionally broken by thicker stones, as in Fig. 2092.

Fig. 2092.



Broken Range Stone Work.

Range work, whether of squared stones, or of ashlar, is usually backed up with rubble masonry, which in such cases is specified as coursed rubble.

Ran'ging Rod. (*Surveying.*) The rod of the chain-man, which is held vertical while being observed by the transit-man.

Heller's self-plumbing ranging rod, for transit field work, is described in * "*Manufacturer & Builder*," xii. 184.

Rar'e-fied Air Ap'pa-ra'tus. Apparatus in which the effect of the diminution of atmospheric pressure on living organisms is observed.

Prof. Bert's investigations are contained in a book of 1168 pages with 89 engravings, referred to in * "*Manufacturer & Builder*," x. 60. See also DEPURATOR, p. 687, "*Mech. Dict.*" The opposite idea is the compressed-air bath. See AËROTHERAPY APPARATUS, p. 9 *supra*, and Fig. 67, p. 31, "*Mech. Dict.*"

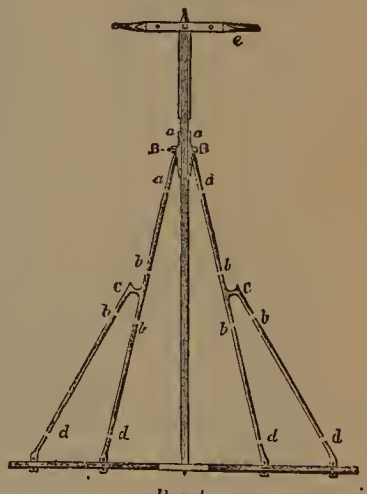
Ratch'et Brace. A boring brace, the handle of which is reciprocated, being effective in one direction only, by means of ratchet and click. Figs. 4175, 4176, p. 1882, "*Mech. Dict.*"

Brace	"*Engineer*," l. 6.
Support for	* "*Scientific American Sup.*," 161.
Drill, *Hutchins*	* "*Iron Age*," xvii., June 1, p. 9.
Lathrop	* "*Iron Age*," xxv., April 15, p. 7.
Renshaw	* "*Scientific American*," xl. 132.
	* "*Iron Age*," xx., July 26, p. 1.
	"*Manufact. & Builder*," xi. 280.
Wrench	* "*Min. & Sc. Press*," xl. 1.
Coleman	* "*Min. & Sc. Press*," xxxvi. 145.
Pawl and ratchet	* "*Iron Age*," xxiii., April 17, p. 11.

Ratchet Coup'ling. A device to uncouple machinery from the driving-wheel when the motion of the latter is suddenly arrested by an obstruction.

A ratchet wheel is placed on the driving-wheel shaft, and slips within a sleeve on the extension shaft. The ratchet is efficient as long as it is a driver, but, if arrested by an obstruction to the master wheel, the sleeve slips on the ratchet and allows the machinery to move on until it loses its momentum.

Fig. 2093.



Reach.

B. Stay end.
C. Offset.
a a. Welding points of stay end and stay iron.
b b. Welding points of offsets and stays.
d d. Welding points of stay end ties.
e. Reach plate.

Ra'tion Press. See BALING PRESS, Fig. 184, p. 69, *supra.*

Rat'tle Bar'rel. A tumbling box for castings, to remove sand, and, in some cases, cores.

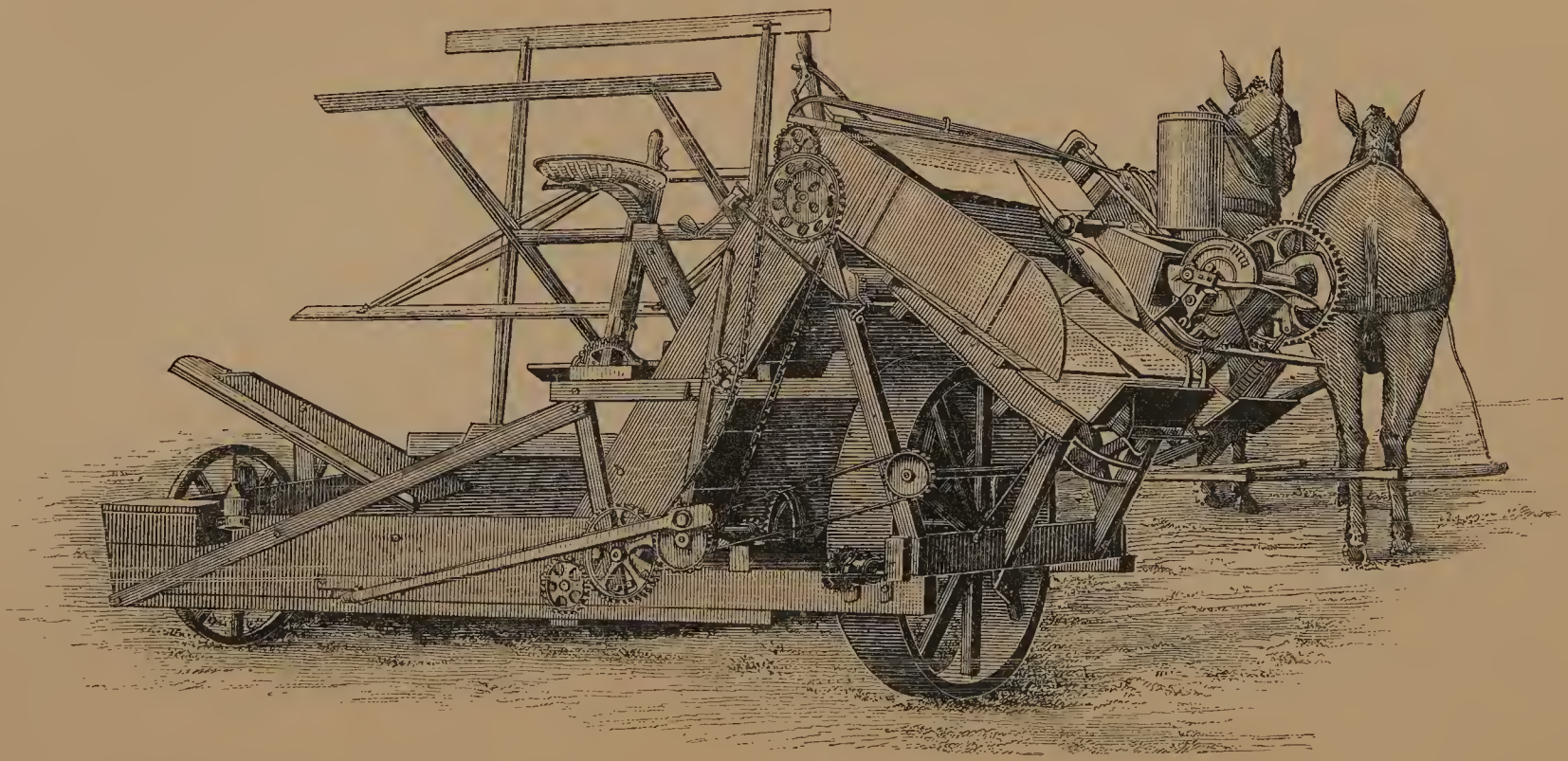
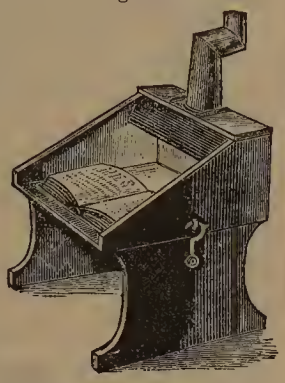


PLATE XLIV. McCORMICK'S TWINE-BINDING REAPER. See page 743.

Reach. That portion of the running gears of a vehicle which connects the fore and hind axles. See Fig. 2093.

Read'ing Lamp. A lamp for ministers and lecturers. It is so screened as not to send any light into the room but to illuminate the reader's notes which are laid upon the desk.

Fig. 2094.



Lecturer's Reading Lamp.

British Museum reading-room. "*Sc. American*," xli. 36.

Reap'ing Ma-chine'. 1. The history and development of the reaping machine from the Gallic implement of the first century, A. D., to the period of the Centennial Exhibition in Philadelphia, 1876, has been referred to, rather than exhaustively told, on pp. 1888–1898, "*Mech. Dict.*" The classification by structural features is given on p. 1898, and illustrations of the 38 principles of action are given in Plates XLVII.–L., pp. 1894–1897, *Ibid.*

The features which the reaper has in common with the mower are considered under MOWER, pp. 1487–1493, "*Mech. Dict.*" The principles of cutting apparatus on Plate XXX., p. 1489, *Ibid.* The classification of mowers by structural features is given on p. 1488, *Ibid.*, and thirty-six illustrations, occupying Plates XXXI.–XXXIII., pp. 1490–1492, show the variations in the following features: —

Modes of connecting the cutting apparatus with the frame.
Modes of driving cutters.
Styles of cutters.
Truck clearers.

The latest classification of harvesters by structure, embracing the whole subject under 141 heads, is given on page 442, *supra*.

The British experiments in building reaping machines from the period of the Boyce patent, 1799, to the Bell machine of 1826, were numerous and unsuccessful. The side cut was tried in 1806, up to which time the machine was pushed ahead of the horses. The knives were rotary until 1822.

The McCormick reaper, invented and put to service in 1831 and exhibited at the London World's fair in 1851, caused the resurrection of a number of old British devices, especially the machine of Patrick Bell (1826) shown in Fig. 4202, p. 1891, "*Mech. Dict.*" The terms of the French award of the Grand Gold Medal of honor in 1855, express the position of the McCormick reaper as "the type after which all the others are made."

While there have been many valuable improvements in detail it may be truthfully said that to dispense with Cyrus H. McCormick's invention would be to wipe every reaper out of existence. The same may be said of mowers, except the small class known as lawn mowers. The original machine of McCormick embraces the following features: —

The serrated reciprocating blade operating in fingers or supports to the grain being cut.

The platform for receiving the cut grain deposited thereon by the reel, and from which it was raked to the side in gavels ready to bind.

A divider to separate the grain to be cut from that left standing.

Two forms of the combined reaping machines, that is, adaptable for either reaping or mowing, are shown in Plate XLVI., p. 1892, "*Mech. Dict.*," the three figures in the Plate showing the machine as a reaper, a dropper, and a self raker. The single reaper is made with but a single driving wheel and is shown in Plate XXX., p. 630, *supra*.

The McCormick "Daisy" reaper shown in the Plate is a single wheel self-raker cutting 5′ wide and weighing 700 pounds. It is a center-cut machine, the ground-wheel and grain-wheel being in line. It has no cogs in the main-wheel. Both ends of the cutter-bar can be raised at the same time by one lever, operatable while the machine is in motion. By a second lever the guards can be tilted up or down to suit the variety of surface or the condition of the crop. By a simple tripping device the operator can regulate the action of the rakes in forming the size of the bundles.

At the Paris Exposition of 1878 there were exhibited, in the field, in Class 76 (the writer being a member of the jury of that class): 4 binding reapers; 21 simple and combined reapers: 1 steam reaper; 16 mowers.

The binding reapers shown at the Paris Exposition of 1878 were 9 in number, 6 American and 3 British. 4 of the American machines went into the field-trials, all of which used wire, and each of the owners has since placed a twine binder on the market. Two twine binders were shown at the exposition, one American and one British, but did not compete in the field.

The four competing machines were those of —

Cyrus H. McCormick,	*D. M. Osborne & Co.*,
Walter A. Wood,	*Aultman & Co.*

The results of the trial at Marmont, near Paris, in 1878, are given in detail under DYNAMOMETER, p. 288, *supra*. The McCormick machine was awarded the grand prize, and subsequently the gold medal of the Royal Agricultural Society of Great Britain, Bristol, 1878, where the same machines competed, and again in 1881, at a competitive trial of the prominent twine binders from England and America at Derby, England, the Royal Agricultural Society awarded the gold medal to the McCormick machine.

The McCormick twine binding reaper is shown in Plate XLIV. The grain, as cut by the reciprocating knife, is delivered by the reel upon the platform, which is a moving web of canvas, which carries it to the elevating aprons which deliver it upon the binding table. The position of the band on the sheaf is regulated for long or short straw by means of a shifting lever, which moves the table backward or forward so as to place the band around the middle of the bundle, either in long or in short grain.

The packing apparatus which regulates the size of every sheaf, making them all uniform, consists of two arms with forked points, which work alternately up through two slots in the table. They rise up quickly, raising the straw and moving it gently forward, pressing it into a receptacle, thus forming a compact bundle, and when the regulated amount has accumulated the pressure against the trip-book removes a stop, thus throwing the binding mechanism into gear. The two curved trip-hooks can be shifted on the sword arm, so as to adjust the bulk of sheaf desired, and when once set for sheaves of any given size, sheaves of that size are continuously made

The binding apparatus consists of a needle arm, gripper, and discharging device, with the necessary gear. The needle arm and part of the discharging device are below the platform, and the gripper, knotter, and two discharging arms overhang the sheaf. After the sheaf has been perfectly tight, and the binding apparatus has been thrown into gear, as described above, the needle arm rises up through the table, carrying the twine with it, and thus encircling the sheaf, places the twine in the gripper, where it is held fast until by a quick motion the knot is tied, the cord cut off, and the discharge arms throw off the bundle to the ground, when the binding apparatus stops and the packers immediately begin the formation of a new sheaf. The discharging device makes the separation between the bound bundle and the unbound grain. The binding material is long-fibered manilla twine. The tension, when once set, binds all bundles with uniform tightness.

The binding apparatus is more specifically shown in Fig. 2095.

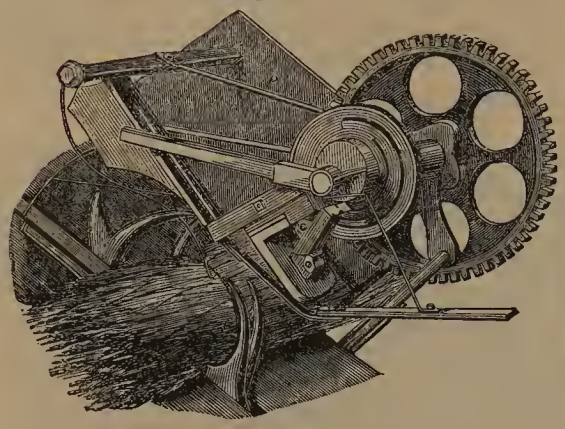
The binding mechanism is attached to that form of American harvester which has traveling platform, elevator, and binding table. The first motion is by a spur wheel on the main axle, 24″ in diameter, which drives a pinion on a countershaft, which, at its opposite end, carries a bevel wheel sliding on a feather and actuated by a clutch under the control of the driver. This bevel wheel drives a bevel pinion on a second shaft, running backwards and forwards and parallel to the main driving wheel; on its rear end is a triple wheel, comprising a small chain wheel which drives the binding gear; a spur-wheel to drive the bottom apron through an intermediate wheel, and a larger chain wheel for the elevator, on the other side of which is the pitman crank, working the knife from behind. The binding mechanism comprises first, a shaft, which runs from back to front of the machine under the binding table. On its forward end is a small chain-wheel, driving on to a square shaft with a loose chain on it, so as to adapt its position to the table when the latter is shifted. On the rear end are two cranks, actuating the packers, which sink through slots on the binding table. On the foremost end of the last-mentioned shaft (No. 4) is a small geared pinion, also loose, with a stop pivoted to it, which is held by a pawl actuated by the compressor. On the extreme end of the shaft, beyond the stop, is a clutch with two driving prongs, which engage into the tail of the stop when the pawl is out of gear. When the pawl comes into gear with the stop, the tail of the latter is so depressed as to allow the clutch to clear it, and so the pinion is thrown out of gear.

This pinion, through two intermediate wheels, drives the knotting-gear, by means of a large spur-wheel on the binder-shaft (No. 5), with cams on both sides; that on the outside works a tension lever for the string.

A crank-pin on the outside cam actuates a crank and rocking-shaft, the opposite end of which carries the needle arm.

The compressor is pivoted on a crank at the back of the needle arm; and it actuates first a rocking-shaft, with a cam which locks the pawl which holds the driving pinion on No. 4 shaft already described; and secondly, the lever of a rock-

Fig. 2095.



The McCormick Twine Binding Mechanism.

ing-shaft, the opposite end of which has a crank connected by a spring rod to a cam roller on the inside of the large cam-wheel on a shaft, No. 5; the object being first to compress the sheaf at the moment of its being tied, and then to depress the compressor after the string is cut, to allow of the sheaf being discharged. The crank to which the compressor is attached has also two light discharge arms which serve to depress the hinged tail-boards of the platform, which are fixed at an angle during the collection and formation of the sheaf, so as to prevent any scatter of straw, etc.

The large tyer-wheel, shown in the illustration (Fig. 2095) is keyed on to shaft No. 5, which goes half-way across the table and drives the knotting gear.

The operations to be performed comprise: —

1. Holding the free end of the string.
2. The action of the needle arm and supply of string.
3. The making of the knot.
4. Cutting the string.
5. Discharging the sheaf.

1. On shaft No. 5, near its center, is a cam-wheel, which actuates a plunging bolt kept against it by a volute spring. In the event of an accident to this spring the same action is secured by a central plunger cam on the end of the shaft No. 5.

The plunger bolt works through eyes attached to the knotter frame, and supports a loose rocking frame carrying the twine-holding disk. This disk is about 2½″ in diameter, and has six smooth-edged recesses, into any one of which the string is guided. One edge of this disk works closely between cheeks, between which and itself, by its revolution, it carries and jams the string, and so holds the free end. The rotary motion is communicated by the plunger bolt, lever and pawl, and ratchet, with a spring-catch on the opposite side to prevent it from turning backward, and so liberating the string.

2. The string, which is fed from a tin canister on the top of the machine through a tension-regulator and taker-up of slack, passes through guide eyes and tubes, to the side of the needle arm and along the needle for about one third of its length, without roller or springs.

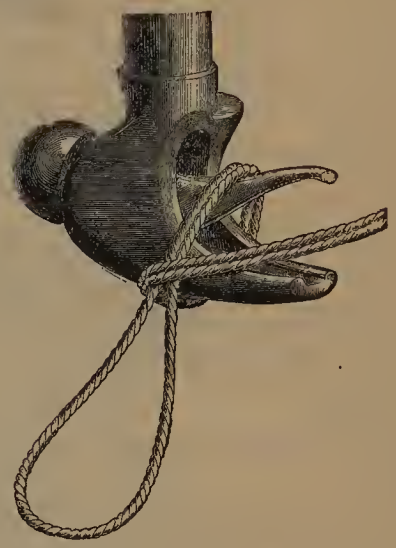
Fig. 2096.

Forming of the Loop by Rotation of the Beaks.

3. The knotter is of the bird-beak type and of the Appleby patent. The lower half of the beak or jaw has simply a revolving motion. The upper beak can be opened by a cam surface and closed by a spring-cam actuating a small roller on the back end of the beak.

The motion for making a knot consists of one complete revolution in one direction only, and is obtained by a short-toothed segment on the cam-wheel on shaft No. 5. Both strands of the string pass over both beaks, as seen in Fig. 2096, and are prevented from getting out of place by a tucker, consisting of a lever actuated by a cam or cam-wheel, and which follows the string as soon as the needle has passed over the beaks; and, without actual contact, it effectually prevents the string getting out of place. At the proper moment for making the knot, the beaks revolve, forming the loop as shown in Fig. 2096. Then the upper beak opens, engages both strings, nips them tight (see Figs. 2097 and 2098), and at this moment the knife-arm pushes

Fig. 2097.



The upper Beak opens to grasp the standing part of the Strings.

the loop over the portion held by the beak, thus making the knot.

4. The knife is fixed to the lower side of the knife-arm, which is pivoted to the knotter frame, and actuated by an inner cam on the cam-wheel on shaft No. 5. It does not actually cut against anything, but it works within a quarter of an inch of a fixed guide which offers the necessary resistance.

Fig. 2098.

The Loop is pushed over the standing part, thus making the Knot.

5. The sheaf is discharged by the action of the light arms, which are seen in Fig. 2095. These arms are keyed on the knotter-shaft, about a foot apart, on either side of the cam-wheel and gear. Their action is simply to push off the sheaf, as the shaft revolves, the hinged platform and compressor arm dropping at the same moment.

A small *butter*, hinged from the top of the frame, with revolving apron, can be set at different angles, according to the length of the crop, these changes being made by the driver whilst the machine is in motion, by a lever-rod. The action of the *butter* is to square-up the butts of the sheaves, and has a very useful office in insuring a neat, compact sheaf. The apron is revolved by bevel gear from the end of the elevator-shaft.

The steam reaper shown at the expositiou was by Aveling & Porter, Rochester, England.

It consists of a wide-swath reaper, ou the "Bell" principle, driven by a traction engine at its rear. It was a striking revival of the machine invented and used by the Rev. Patrick Bell, at Forfar, Scotland, in 1828, but cut a swath of 12′ wide at the rate of 2½ miles per hour, over double the work of the Scotch machine. This was no extraordinary advance in point of economy, as the Bell machines worked with two horses and laid the swath in the same manner. The Aveling & Porter machine had a nominal power of five or six times as great.

Like its prototype, the tongue of the machine extends to the rear, the power being behind, but, instead of a pair of horses hitched to the end of the tongue and facing their work, a 10 or 12-horse traction engine pushed the reaper into the grain, the cutting apparatus, grain-reel, and endless discharge-apron being worked by gearing driven by an endless chain from a sprocket-wheel or the fly-wheel shaft of the engine. The endless apron is inclined, and discharges the cut grain in a regular and continuous swath on the left of the machine, with the butts towards the engine and out of the way of the latter, which followed in the rear.

In front of the engine is a crane with tackle operatable from a drum, which may be thrown in connection with the engine when required. During the turning of corners while at work, and in transporting the apparatus to and from the field, the reaper is lifted and hangs suspended from the crane.

The machine is operated and guided by one man, the various levers being conveniently placed; so that the reaper may be raised or lowered, the locomotive moved forward, backed, or guided to left or right, and the gearing which controls the functions of the reaper proper put into or out of operation.

The machine did very good work, but it can hardly be said that it was regarded as of much practical value.

See also the following references: —

Steam, *Aveling & Porter*, Br. . . . . * "*Engineer*," xlii. 148.
* "*Scientific American Sup.*," 566.
* "*Engineering*," xxii. 32.

Reaping machine.
Burgess & Co., Br. . * "*Engineering*," xxiv. 45.
Howard, Br. . . . * "*Engineering*," xxii. 52.

Tests, Leamington.
Br., 1876 . . . . . "*Engineer*," xlii. 151.

Trials, table of tests . "*Engineering*," xxii. 190.
Wood . . . . . * "*Engineer*," xli. 22.

Binding reaper.
Howard, (details) Br. * "*Engineer*," xlviii. 431.
Howard, Br. . . . * "*Engineering*," xxviii. 7.
Mc Cormick (details) . * "*Engineer*," xliv. 114.
Samuelson, Br. . . * "*Engineer*," l. 435.
Wood . . . . . * "*Iron Age*," xix., June 21, p. 1.
W. A. Wood . . . . * "*Engineer*," xlv. 163.

Wire cutting pliers.
Miller . . . . . * "*Scientific American*," xli. 18.

Harvester, *Crawford & Co.*, Canada . . . . * "*Scientific American*," xliii. 83.

Binder, Johnston . . . * "*Iron*," Aug. 17, 1878.

Harvester, "Centennial."
Cal., *Rice* . . . . . "*Min. & Sc. Press*," xxxvii. 55.

Dr. Knight's report, on Class 76 at the Paris Exposition of 1878, gives views and description of the following. See "*Paris Exposition* (1878) *Reports*," vol. v., pp. 124–149.

Binding reaper, *Cyrus H. McCormick* . .	United States.
Binding reaper, *Walter A. Wood*	United States.
Binding reaper, *D. M. Osborne & Co.* . .	United States.
Binding reaper, *Johnston* (string binder) .	United States.
Binding stick	France.
Automatic binding implement	France.
Sweep rake harvester, *Johnston*	United States.
Sweep rake harvester, *Warder, Mitchell & Co.*	United States.
Sweep rake harvester, *Hornsby*	England.
Sweep rake harvester, *Howard*	England.
Dropper, *Cumming*	France.
Single horse reaper, *W. A. Wood*	United States.

2. A file having two parallel flat sides and two inclined edges, all flat.

Rear'cut Mow'er. One the cutter bar of which is in the rear of the axle of the carriage. As distinct from *front cut* and *middle cut*. See upper figure in Plate XLVI., p. 1892, "*Mech. Dict.*"

Rear Sight. The hind sight of a gun, rifle, or cannon. There are various kinds: *open, peep, vernier, California*, etc. See list under SIGHT. See also HAUSSE.

The rear sight of Russian cannon. "*Ordnance Report*," 1877. Col. Benton's report and Appendix L, p. 578, and Fig. 1.

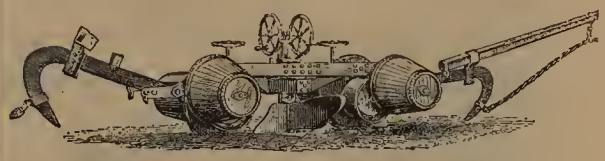
Re-cap'per. A tool used in reloading shells, to put the cap on its seat in the end of the shell. See RELOADING TOOLS.

Rec'la-ma'tion Plow. A plow for breaking new land, grubbing its furrow among roots and stones.

Fig. 2099 is the plow used in the stony tracts of Sutherlandshire, Scotland. It is used in connection with the ordinary steam plow engine.

The plow is preceded by steel disks, which lift the share over stones or other obstructions, so as not to break it or the moldboard. The plow will turn a furrow 2′ wide and

Fig. 2099.



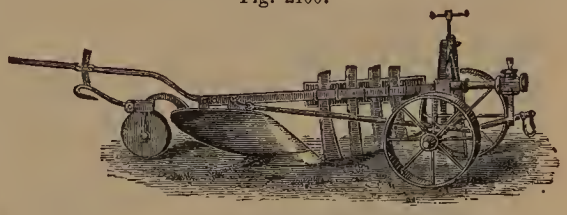
Fowler's Steam operated Land Reclamation Plow.

15″ deep completely over, an operation materially assisted by the rollers, which catch the furrow-slice at the moment of leaving the moldboard. The stones which have been passed over are torn out by the hook-tine which comes behind the plow. They are then removed by men with teams and stone-boats. The tine thoroughly subsoils the land to a depth of 2′, and materially assists the drainage of the soil.

The plow for horses or oxen is a strong one, of ordinary form, but with a stiff and sharp colter for cutting roots. Incidentally many of our heavy plows are calculated for such work as it may occur. Others, like our prairie-breakers, are for stubborn sod, wild-grass meadows, and low situations with patches of willow or hazel, brambles or rose bushes, as the case may be.

The *déboiseuse*, or French clearing plow, Fig. 2100, is designed for clearing ground which has grown up in thickets

Fig. 2100.



Clearing Plow. Delahaie-Tailleur & Bajac, Liancourt, France.

or copses. It is made with 2, 3, 4, 5, or 8 cutters in advance of the plow proper. Each cuts into the land below the preceding one, so that a *déboiseuse* of 5 cutters will divide the roots to an ordinary plow depth.

Re-coil' Check. 1. An apparatus to absorb the recoil of a cannon, otherwise known as a hydraulic buffer, which see.

See 10″ gun-carriage, with hydraulic recoil check. Plate VI., attached to Appendix H, "*Ordnance Report*," 1876.

2. A spring cushion attached to the butt-end of a gun-stock to take the force of the recoil.—*Miller*, No. 169,465.

Re-coil' Dy'na-mom'e-ter. An instrument to measure the recoil of small arms.

Lieut. Metcalfe's device is to measure the recoil by substituting for springs a material of uniform resistance, such as copper or lead, and measuring the recoil by means of a cut made in the material by a Rodman knife interposed between the metal and the butt of the gun. See "*Ordnance Report*," 1878, Appendix N, p. 109, and plate.

See CRUSHER GAGE; PIEZOMETER, and references *passim*.

Rec'tal Di-la'tor. (*Surgical.*) A flexible caoutchouc tube, introduced *per anum*, and then inflated, to distend a constricted bowel. — *Dr. Wales.*

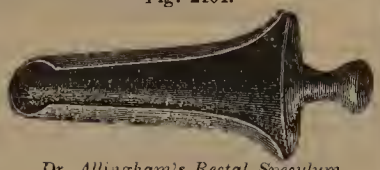
See also ANAL DILATOR, pp. 30, 31, *supra*.

Rec'tal In'stru-ments. (*Surgical.*) The list includes: —

Anal dilator.	Hemorrhoidal clamp.
Anal fissure knife.	Insufflator.
Bistoury.	Irrigator.
Bougie.	Ligator.
Cautery irons.	Puncturer.
Cystotome.	Pile clamp.
Curette.	Pile needle.
Dilator.	Porte-caustic.
Divulsor.	Porte-meche.
Dressing forceps.	Probe.
Electrode.	Speculum.
Endoscope.	Sphincter ani dilator.
Enema pump.	Sponge holder.
Exploring needle.	Suppository.
Feeding tube.	Syringe.
Fistula scissors.	Tenaculum.
Forceps.	Trocar.

Rec'tal Spec'u-lum. (*Surgical.*) A distending instrument for displaying the mucous surface of the rectum. See ANAL SPECULUM, p. 31, and references *passim*.

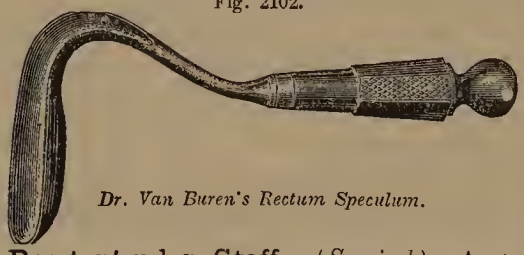
Fig. 2101.



Dr. Allingham's Rectal Speculum.

Figs. 2101, 2102, show two forms, both metallic.

Fig. 2102.

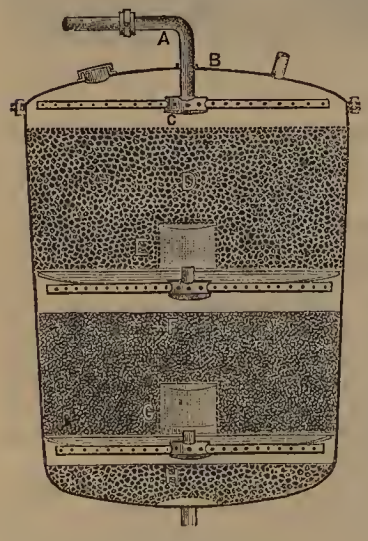


Dr. Van Buren's Rectum Speculum.

Rec-tan'gu-lar Staff. (*Surgical.*) A staff bent at a right angle, serving as a director for the bistoury in the operation of lithotomy.

Rec'ti-fi'er. *Add.* A filtering apparatus for deodorizing and purifying spirits. It usually consists of a leach tub through which the raw spirit percolates through animal charcoal.

Fig. 2103.



Rectifier.

Fig. 2103 shows a forcing apparatus in which the liquor under a pressure of 50 pounds per square inch is introduced by pipe *A*. *B* is the cover of the rectifier; *C*, the radial arm distributer; *D*, the upper chamber packed with charcoal free of dust; *E*, the perforated bonnet chamber outlet to distributer underneath; *F*, the second chamber packed with finer coal than the first; *G*, the perforated bonnet chamber outlet to the bottom chamber; *H*, the bottom space and blanketed strainer discharge to delivery pipe, whence the rectified liquor is conveyed to the receivers.

Rec'ti-lin'e-ar E-cra'seur. (*Surgical.*) An écraseur which, instead of a wire loop or chain loop, has a clamp the jaws of which have a fin and groove respectively.

Rec'to-co-lo'nic Ap'pa-ra'tus. (*Surgical.*) Instruments which reach the rectum and colon, such as some forms of endoscopes and enema syringes.

Re-cu'pe-ra'tor. A name applied, sometimes, in England to the *regenerator* of the Ponsard or Siemens furnace.

See REGENERATOR, and references *passim*. See "*Engineer*," * xlvi. 231.

Red Lit'mus Pa'per. (*Gas.*) Used as a test to show the presence of ammonia in illuminating gas.

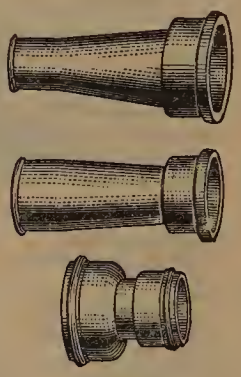
Take 6 parts by weight of water and one of powdered litmus, shake, allow to stand several days. Then add, drop by drop, a small quantity of dilute sulphuric acid until the pink or neutral tint is obtained. Pieces of white filtering paper are then soaked in the solution, dried, cut in pieces of convenient size, and kept in a stoppered bottle.

Re-dres'sor. (*Surgical.*) A replacing instrument, *e. g.*, the uterine redressor.

Re-du'cer. A joint-piece for connecting pipes of varying diameter.

The term is also applied to other pipe connections where one of the members has a smaller diameter. See BRANCH, CROSS, TEE; also list under PIPE COUPLING.

Fig 2104.



Reducers.

a, *b*. Reducing pipes.
c. Reducing hub.

Re-du'cing Coup'ling. A pipe coupling with ends of varying diameters, to unite pipes of different sizes.

Re-du'cing Press. In sheet-metal working, an auxiliary press for the further deepening and drawing of articles partially struck up.

Re-du'cing Squares. A mode of making reductions of drawings or designs. The original has lines drawn over it, dividing it off into squares, as numerous as the nature of the picture may require.

A piece of paper of the size desired is then divided into a similar number of squares, and the objects contained in the former squares delineated in the smaller ones.

A frame with crossing threads or wires may be laid over the original. The same frame may be erected in front of a person at a desk so as to divide a landscape in the same manner.

Re-du'cing Tee. A T-shaped pipe coupling, the arms of different diameter from the stem, to unite pipes, joining at right angles and having different diameters.

Re-du'cing Valve. A device in the West-

Fig. 2105.

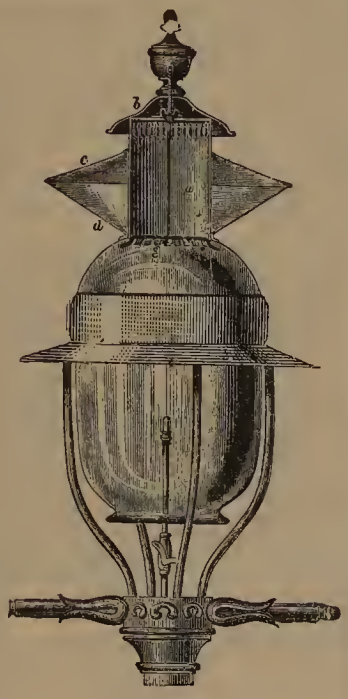
Reflecting Drawing Board.

inghouse automatic railway brake to regulate the pressure on the brakes, so as to insure the proper degree of retardation without skidding the wheels, at varying speeds.

Fig. 1, p. 85, "*Engineering*," xxvii.

Re-flect'ing Draw'ing Board. An arrangement to assist in copying drawings. See Fig. 2105.

Fig. 2106.



Reflecting Lamp.

The drawing to be copied is placed on the board to the left of the glass and the blank paper on the right. The artist stands so as to view the surface of the glass obliquely, and the original drawing is reflected from the surface of the glass to his eye, and at the same time he sees the surface of the white paper through the transparent glass, so that the lines of the drawing appear as upon the white paper, but reversed in position. These apparent lines are to be followed with a pencil on the blank paper.

Re-flect'ing Lamp. A lamp with upper reflector to throw down the upward beams.

Fig. 2106 shows a form for street use. It exhibits front half of top chimney and upper reflector cut away.

a. Chimney.
b. Chimney cap.
c. Cover to upper reflector.
d. Upper reflector.
g. Metallic clasps on chimney bent against inside of the glass.

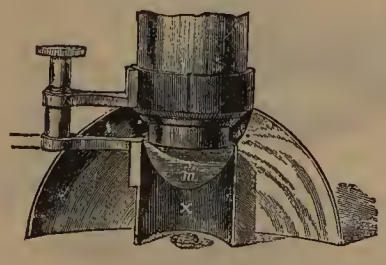
Re-flect'ing Sight. (*Fire-arm.*) The sight has a reflecting surface placed at such an angle as to reflect to the eye light from one direction only.

Stillman's patent . . . . . No. 33,965.

Reflec'tor. (*Optics.*) Sorby's addition to Beck's parabolic illuminator, consisting of a plain silvered mirror covering one half of the aperture of the object-glass.

The rays falling upon it are thrown down upon the object, and reflected direct up the tube of the microscope, thereby

Fig. 2107.



Reflector.

producing a mode of illumination exactly the reverse of that of the parabolic illuminator, where the rays impinge at an oblique angle, and so only those diverted by the object enter the field of view.

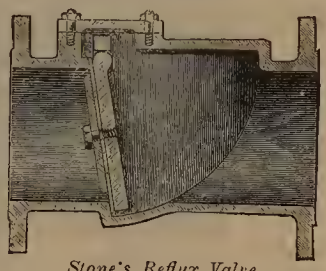
See also ILLUMINATOR, p. 1171, "*Mech. Dict.*," where the *opaque*, *white cloud*, *oblique*, and *black ground* illuminators are described. See also CONDENSER, SIDE REFLECTOR, PARABOLIC ILLUMINATOR, PARABOLIC REFLECTOR, LIEBERKUHN, SPOT LENS, CATOPTRIC LIGHT, MIRROR, etc., *Ibid.*

Reflector candle, *Meigs* * "*Scientific American*," xl. 261.
Gas light, *Bailey* . . . * "*Iron Age*," xxi., May 9, p. 5.
Reflecting Illuminator.
Balestrieri . . . . * "*Scientific Amer.*," xxxiv. 367.
Shive . . . . . * "*Scientific Amer.*," xxxiv. 406.
Reflector, Parabolic . . "*Scientific Amer.*," xxxvi. 180.

Re'flux Cath'e-ter. (*Surgical.*) A double-current catheter which allows the liquid to pass by one duct and return by another. Fig. *c*, 1190, p. 504, "*Mech. Dict.*" See also DOUBLE-CURRENT CATHETER, p. 266, *supra*, and references *passim*.

Re'flux Valve. An automatic valve to prevent reflux. A back-pressure valve.

Fig. 2108.



Stone's Reflux Valve.

Fig. 2108 shows Stone's cast-iron reflux or back-pressure valve, with clear straightway, to keep the water in mains when the pressure is taken off.

Re-frig'e-ra'tor. The storage, domestic, and railway car refrigerators are referred to on pp. 1910, 1911, and Figs. 4238–4243, "*Mech. Dict.*"

The subject of cooling is also included under ICE MACHINE, pp. 1164–1169, and Plate XXVI., *Ibid.*; ICE-CREAM FREEZER, *p. 1162; LIQUID COOLER, *p. 1326; BEER COOLER, *p. 264; CONDENSER, *p. 607, *Ibid.*

In the refrigerator car used for transportation of California fruit eastward, the car is attached to one of the regular passenger trains, and is provided with a fan-blower, driven by one of the axles, by means of which the air is forced through the ice-chamber and thus reduced to a low temperature. This chilled air is distributed among the fruit-boxes through a large perforated pipe laid along the bottom of the car. After it has circulated among the fruit, it returns to the blower, and is again forced through the apparatus. By this means the atmosphere of the car is kept at the uniform temperature of 40° Fah.

Refrigerator basket.
Hare . . . . . * "*Scientific Amer.*," xxxix. 290.
Cars . . . . . * "*Scientific Am. Sup.*," 1411, 1119.
Tiffany . . . . . "*Iron Age*," xix., April 26, p. 23.
* "*Railroad Gazette*," xxi. 311.
Winants . . . . . * "*Scientific American Sup.*," 276.
Cellars and storerooms.
Pictet . . . . . * "*Manufact. & Builder*," x. 182.
Chambers for ocean transport . . . . "*Scientific American Sup.*," 237.
French . . . . . * *Laboulaye's* "*Dict.*," iii. "*Refrigerant.*"
Apparatus for glaciaria.
Gamjee, Br. . . . * "*Engineer*," xli. 378.
For ships, etc., *Pictet* . * "*Manufact. & Builder*," x. 121.

Re-gen'er-a'tor. A chamber in which the outgoing waste gases heat the incoming air.

They are of two kinds:—

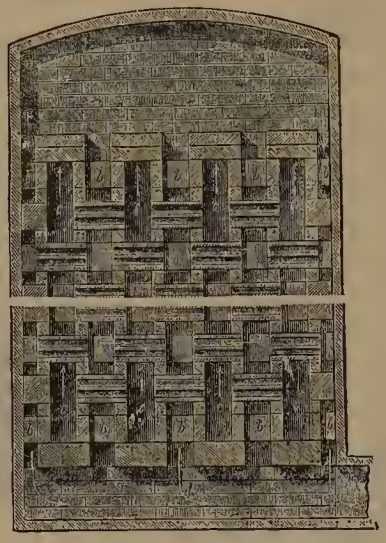
1. Those in which, as in the Ponsard furnace, the waste gases descend through one set of channels inclosing another set through which the incoming air passes, the walls heated by the waste imparting heat to the air. This is on the principle of many feed-water heaters for boilers; and many other instances might be cited.

Fig. 2109 shows the Ponsard regenerator, which is a chamber with a built-in arrangement of hollow refractory bricks. The waste gases from the laboratory or combustion chamber of the furnace come in above, descend through the conduits *b b*, and escape below to the chimney, either directly or after having passed through the flues of a steam boiler, to be therein farther utilized.

The cold air enters below at openings provided with registers, and passes upward through the conduits *c c*, intermediate between the driving flues *b b* of the waste gases, and thence passes to the combustion chamber. The passages *b b* mutually interchange by means of hollow bricks, and so do the passages *c c*. See also GAS-GENERATING FURNACE, Figs. 1161, 1162, p. 387, *supra*.

In Frank's regenerative gas furnace, Fig. 2110

Fig. 2109.

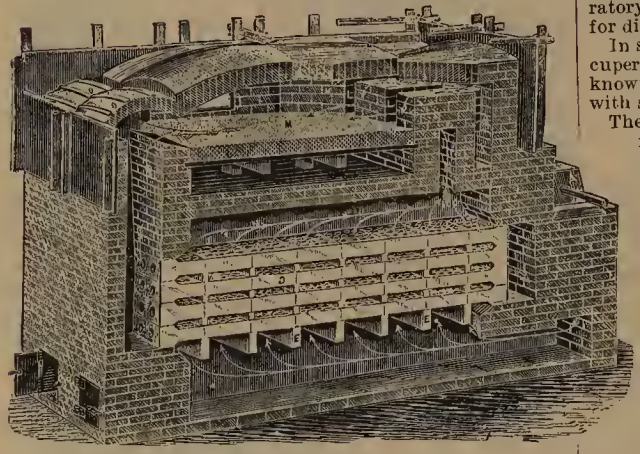


Ponsard Regenerator.

the gas is made in a producer built against the furnace at the right.

The air from the producer enters from the right and is diverted right or left to one or the other regeuerator, there being two of them. Passing beneath the regenerator the gas courses upwardly among the stack of hollow blocks *G* and thence to its point of junction with the air which is diverted

Fig. 2110.



Frank's Regenerator Furnace for Glass.

by valve *A* to pass through the other regenerator. The gas and air respectively pass through vertical openings in the blocks *G*, while the hot current from the furnace *M* courses through the horizontal openings in the said blocks and thence to the stack.

2. The other form of regenerator is that invented by M. M. Siemens, and has two pairs of chambers used in pairs alternately.

The chambers have bricks piled up in them, and stacked loosely together so as to expose a great surface. The draft of waste gases passes through one pair of chambers which are for the time being in the line of communication between the furnace chamber and chimney: and the bricks are heated. The other pair previously heated is placed in the duct by which gas and air pass to the furnace chamber, extracting in their passage heat from the bricks. By turning a valve the relation of the respective regenerators is changed. See Figs. 1159, 1160, p. 386, *supra*.

Furnace, *Siemens* . . * "*Engineering*," xxvi. 41.
* "*Iron Age*," xx., Dec. 20, p. 3; xxii., Nov. 14, p. 3.
* "*Manufact. & Builder*," xii. 270.
* "*Am Man.*," Sept. 12, 1879, p. 12; May 7, 1880, p. 7.
Troy, N. Y. . . . . * "*Engineering*," xxx. 615.
Springfield, Ill., *Pernot* * "*Engineering*," xxix. 374.
"*Engineer*," xli. 20, p. 30.
* "*Am. Man. & Iron World*," xxiv., April 25, p. 8; May 2, p. 8.
Siemens . . . . . * "*Am. Man. & Iron World*," xxv., May 7, p. 7.
Ponsard . . . . . * "*Scientific American Sup.*," 2355.
Stoves, on, *Hartman* . * "*Engineer*," xlix. 359.
Crown Point, N. Y. . . * "*Engineering*," xxv. 216.
Cowper, Br. . . . . * "*Engineering*," xxviii. 212.
List and descriptions . "*Scientific American Sup.*," 3738.

Re-gen'er-a'tor Fur'nace. A furnace in which the outgoing waste heat is made to heat the incoming air of combustion.

Practically, in metallurgy, also in glass and gas works furnaces, the principle has been so much extended that the definition is incomplete as to the best examples of this class. Such are the *Siemens*, *Bicheroux*, and *Ponsard*, for instance, though there are others comprised in the same class.

In the improved form the regenerators are 4 in number, working in pairs. Through one pair the waste heat passes, heating the bricks which are built up in a cellular structure within side of the chamber and thereby absorbing a large portion of the escaping heat. When this is accomplished, a damper is turned, when the waste heat is turned through the other pair of regenerators in order to heat them, and the chambers of the former pair are devoted, one of them to heat the gases coming from the producer, and the other to heating the incoming air which is to be mixed with the said gases on entering the puddling or pot chamber, as the case may be.

Fig. 1999, p. 701, shows the gas producer with its fuel. The grate differs from the Siemens furnace in having a lower horizontal portion on which the depth of the bed of fuel varies according to its composition. The upper part is at the ground level and has one or more feeding shafts with covers. Holes are provided for inspection and stoking. A damper of refractory clay is capable of being slipped in or out to govern the size of the flue conducting the heated gases to the laboratory, as the chamber where the work is performed is called for distinction.

In some cases the fire is fed with heated air from the recuperator, in which case grates are not used. Such are known as superheated gazogens. They are sometimes blown with steam jets or injectors.

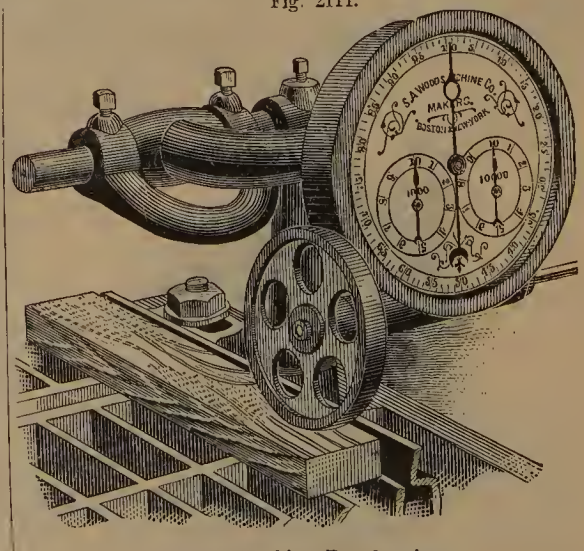
The subject of the methods of using, the purposes of the furnace, and the chemical reaction are considered under GAS-GENERATING FURNACE, pp. 384–388, *supra*. See also REGENERATOR.

Reg'is-ter. A device for recording.

See list, examples, and references on pp. 1912, 1913, "*Mech. Dict.*"

The register shown in Fig. 2111 is for showing the sum of the lengths of boards or other stuff run through a planing machine. The circumference of the wheel is a known quantity and each revolution is registered on the counter, the dials of which represent units, hundreds, and thousands of feet.

Fig. 2111.



Planing Machine Board-register.

Reg'is-ter-ing Scale. A weighing scale made by *Chameroy* of Paris, which, by pressure upon a stud, impresses upon a slip of card the weight of the object on the scale. See SCALE.

Reg'is-ter-ing Ther-mom'e-ter. One which has a means for indicating the highest or lowest point reached between observations.

Registering thermometers are considered on pp. 2548, 2549, "*Mech. Dict.*"

A new registering thermomcter by M. Hervé Mangou has a long and fine capillary tube bent on itself, supported by an iron frame, and containing mercury; it passes through the stopper of a bell jar and terminates with a fine point in a mercury dish placed in one scale of a balance; the other scale contains a vessel of glycerine communicating by glass and india-rubber tubing with another glycerine vessel on the same level in an adjoining frame. When, on rise of temperature, mercury is forced out into the vessel. the balance is depressed on one side and an electric contact made, affecting an electro-magnet in the registering apparatus, which is composed of M. Redier's double wheel work with differential train. When the depression referred to has occurred, a suspended float in the second glycerine vessel descends, and raises the glycerine in the first, increasing the weight in that scale. The curve obtained (from a pencil on moving paper) is of zigzag form, the wheel-work being in constant motion, now to the right, now to the left.

See also * "*Scientific American Supplement*," 125, 935.

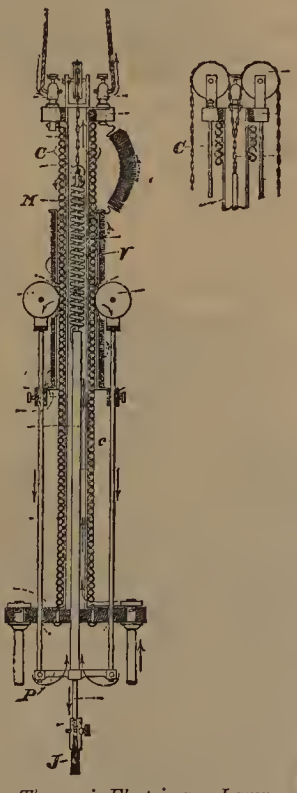
Reg'u-la-ting Valve. One for graduating the effective opening in a pipe to determine the amount of fluid passing.

Reg'u-la'tor. (*Electricity.*) 1. The shield for covering or uncovering the core, thus exposing it more or less to the magnetism of the coil, and in this way regulating the current.

Regulator for induction coil.
Floyd . . . . . * "*Scientific American Sup.*," 2425.

2. The apparatus for maintaining the relative distance between the carbons in the voltaic arc light. See ELECTRIC LIGHT.

Fig. 2112.



Thomas' Electric-arc Lamp Regulator.

Thomas's regulator for electric arc lamps in series is shown in Fig. 2112.

The figure shows a section in the plane of the lamp's geometric axis; the negative electrode being omitted. Also in a smaller figure the solenoid to a larger scale.

Illuminative equilibrium throughout the series is secured by the respective attraction toward and repulsion from a prime helix *C* on the line of its axis, of two helical current-carriers *M V*, both integrally attached to holder *P* of positive electrode *J*. Of these current-carriers one, *M*, is a solenoid through which current reaches the electrode from the prime helix. The convolutions of this solenoid are such as to cause its upward attraction by the prime, proportional to the strength of the main current. The other carrier, *V*, possesses such resistance as to be comparatively inert during normal or less than normal separation of electrode-points, while extreme electrode separation, on the other hand, operates to shunt portions of current around the electrodes through said carrier. Said carrier, being so wound as when thus energized to be repelled downward by the prime, operates to antagonize and even reverse such excessive lifting action of carrier *M* as would tend to greatly weaken the series-current and to extinguish the weaker lamps.

Strong and broken arrows indicate respectively the course of the main and shunted currents.

Re'in-force'. (*Cartridge.*) A lining or plate to strengthen the head of a cartridge, sometimes also acting as an anvil or a gas check. See CUP ANVIL; DISK ANVIL; GAS CHECK.

Re-lief' Print'ing. A process applied by Thuillier, of Rouen, and Petit-Didier, of St. Denis, to silken tissues, which are scattered over with brilliant points in relief, and of different colors so as to imitate embroidery.

It is executed with a resinous matter, either colored or left colorless, which is deposited upon the tissue in melted drops by means of a plate engraved in relief. On cooling, these drops acquire hardness enough to form, so to speak, a part of the tissue and to resist friction.

Depouilly and Meyer have devised something analogous for fixing upon very light tissues, like tulles, brilliant drops in relief, which by their limpidity recall pearls or precious stones. They are obtained by means of gelatine or gums deposited while liquid by means of pins arranged symmetrically. This style has been named "diamond tulle." — "*Teinturier Pratique.*"

See also instances referred to under PHOTO-PRINTING PROCESS, pp. 676, 677, *supra.*

Re-lief' Pro'cess. See photo-relief process, "*Mech. Dict.;*" RELIEF LINE ENGRAVING, p. 1915, *Ibid.*

In Joyce's mode of producing relief-plates for printing, a smooth steel plate is covered evenly with a thin coat of plaster of Paris and potter's clay: the design is then drawn through this (as through wax in etching) down to the plate. A stereotype-metal cast is taken from this reverse-plate, giving lines in relief.

Relief blocks from photos. "*Scientific Amer.*," xxxiv. 196.
Relief stamping press, paper monograms, etc.
Richmond, Br. . . . * "*Engineer*," l. 312.

Re-lief' Valve. An automatically acting valve which yields to a given pressure to avoid bursting of the object to which it appertains.

1. For barrels containing beer or other effervescent or fermenting contents.

2. For pipes of beer-engines.

3. For regulating the pressure in fire engine hose. *Bailey; Blake.*

Fig. 2113.

Reliever.

4. For discharging condensed steam from cylinders during intervals of rest. — *Bagshaw*, Br., * "*Engineer*," xlvi. 427.

5. For turning the feed water into the hot well when the boiler is sufficiently full.

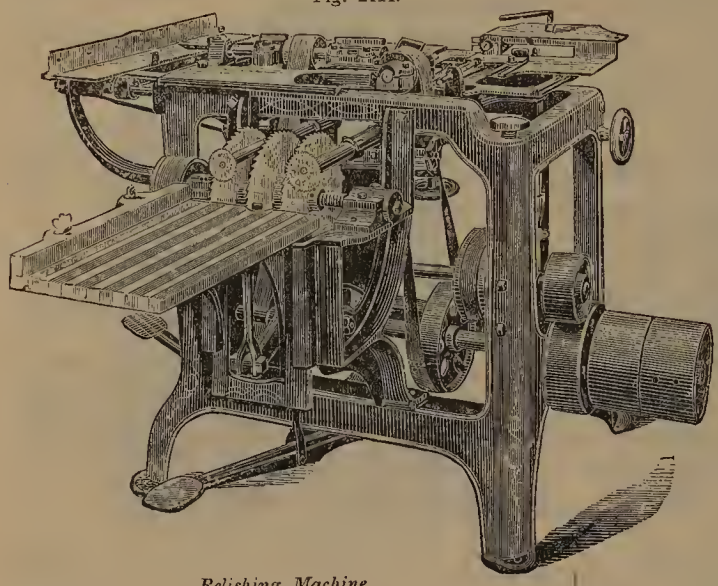
6. To provide escape for feed water when shut off from the boiler, the pump continuing to work. — * "*Scientific American*," xxxvi. 351.

Re-liev'er. (*Nautical.*) A device for attaching the wire shrouds or stays of yachts to the hull. It is an elastic connector involving the compression of a caoutchouc block and giving a certain amount of resiliency to the tension, to avoid breakage of the stay, rope, or what not.

Rel'ish-ing Ma-chine'. A machine for shaking the shoulders of the tenons which bear against the rail of the door, sash or blind.

The machine shown is for sash, window, and blind relishing and for mortising. Such stuff is relished at one operation and handling. Blinds are relished and recess made for end of rod at one operation. The meeting and bottom rail are mortised at one operation by a

Fig. 2114.



Relishing Machine.

hollow chisel. The door relishing is done at one operation by the five saws shown to the left. All the parts described may be run simultaneously.

Greenlee . . . . . * "*Engineer*," xli. 430.

Re-load'ing Tools. For reloading spent capsules of breech-loading fire-arms. A complete set for rifle cartridges consists of primer extractor, charger, loader, and reprimer, which see.

Fig. 2115 shows a single tool with the functions of decapper, recapper, and rammer comprised within a weight of

Fig. 2115.

Reloading Tools for Breech-loading Shot-guns.

5 oz. On the side is also a device for extracting expanded shells. — *Providence Tool Co.*

Fig. 2116 is a tool which removes the exploded primer, in-

Fig. 2116.

Reloading Tool for Breech-loading Rifles.

serts the new primer and fastens the ball in its shell, at the same time swaging the cartridge to form.

Rep. (*Fabric.*) 1. A French worsted goods, usually for furniture, made of long combed wool on loom with taffetas armure.

2. A double threaded taffeta with a cotton warp and medium wool weft.

Re-peat'ing Ri'fle. One which fires charges consecutively from a magazine.

The German repeating rifle, made at the School of Musketry at Spandau, is a Mauser rifle with magazine attachment. The magazine is made from steel plate, and contains 11 cartridges. It can be readily put off and on the rifle, and is worked on it solely by opening and shutting the chamber in such a way that at every opening movement a cartridge falls through the groove into the rifle, and by every shutting movement the next cartridge is made ready for use. This apparatus can be attached to all breech-loaders with a cylinder breech. By it 12 rounds are fired in 24 seconds; the magazine can be refilled in 15 seconds. When the magazine is removed the piece forms an ordinary one-barrelled gun

See also MAGAZINE GUN, pp. 570 *et seq.*, *supra*, and "*Mech. Dict.*"

Rifle, *Winchester*, 1878 * "*Min. & Sc., Press*," xxxvi. 241.

Spandau, Ger. . . * "*Amer. Manufact.*," 1880.

Re-pel'lent. (*Fabric.*) A waterproof cloth.

Re-pla'cing Ap'pa-ra'tus. (*Railway.*) For the replacing of derailed rolling stock upon the line.

N. Ry. of France . . . . * "*Engineering*," xxvii. 459.

Re-plen'ish-er. (*Electricity.*) *a.* A dynamo-electric device of Sir Wm. Thomson, which, in a few revolutions of the armature, induces a static charge of considerable magnitude from primary charges which are practically infinitesimal.

"*Engineering*" . . . . . xxiii. 319.

b. That part of an electrometer (Thomson electrometer) whereby the normal charge of the indicator-needle is maintained by occasional connection with a condensor. — *Gordon*, i., p. 42.

Re-pos'i-tor. (*Surgical.*) A replacer. The uterine repositor or elevator, for instance.

Repousse. (*Fine Art Metal-working.*) A mode of forming and ornamenting silver-ware by blows delivered internally.

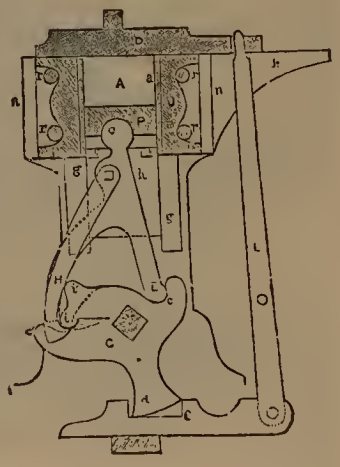
It is done by means of a snarling-tool (Fig. 5248, "*Mech. Dict.*"), which is planted in a vise, while its outer end rests against the interior of the object. A blow on the shank of the snarling iron is transferred to the object and causes an interior dent and an outward bulge.

The Bryant vase is a remarkable success of Tiffany & Co. in this line of ornamentation.

Re-press'ing Press. A machine compacting partially dried bricks by a second pressure, giving them hardness, smoothness, and symmetry.

In Anderson's press, Fig. 2117, the mold is lined with sheet steel, and may be replaced when worn out. In the sectional view *A* is the mold in which the brick is pressed; *D*, the cap which slides sidewards to the right over the surface *b*, being driven in that direction by the lever *L*, when at the same time the bottom plunger *P* is raised by means of a toggle-joint which elevates the arm *H* by the turning of the cam *G* round its axis, while the projection *d*, fitting in a notch, moves the sliding piece *f* to the left, which acts on the lever *L* and cap *D* mentioned before. By this combined motion the

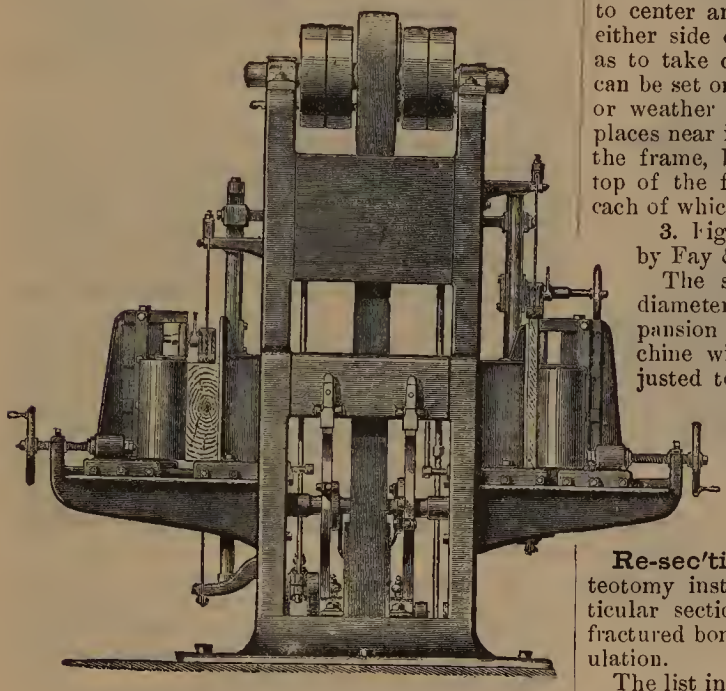
Fig. 2117.



"*Champion*" *Repressing Press.*

mold *A* is simultaneously uncovered, and the plunger *P* moved to the top of the machine flush with the upper surface of the sides of the mold. When the brick is placed on the surface of the plunger *P*, by a reverse motion it descends with the brick, the cap *D* slides over the mold and is kept in place by proper grippers, secured with nuts shown in the large cut; and by continuing the motion of the cam *C* in the same direction, the arm *E* of another toggle-joint is put in operation, which lifts the plunger sufficiently to press the brick upwards against the cap *D*. The shaft *t* is moved with a long lever at its outer end, for producing the motions described. By throwing this lever backward, the plunger *P* descends, the cap *D* glides to the right, and by further motion of the same, the arm *H* lifts the plunger to the top of the mold, pushing the brick out, when it can be removed and another substituted.

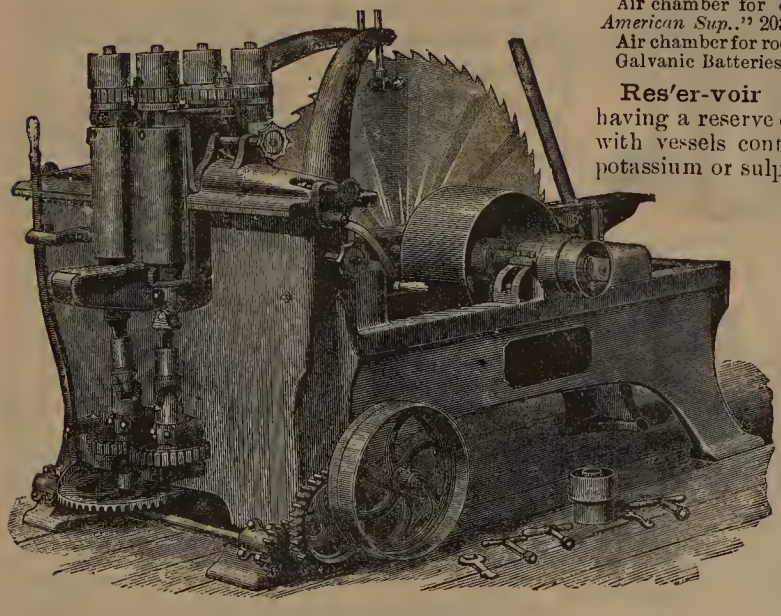
Fig. 2118.



Reciprocating Resawing Machine.

Re-pri'mer. An implement for setting a cap upon a cartridge shell. One of the set of RELOADING TOOLS, which see.

Fig. 2119.



Circular Resawing Machine.

Re-saw'ing Ma-chine'. A machine for sawing timbers and balks of lumber into dimension stuff.

They are of three kinds: *reciprocating, circular, band.*

1. Fig. 2118 is a double resawing machine of the reciprocating order, made by Richards, Loudon, & Kelly, for working on dry lumber up to 8″ thick and 30″ wide. The speed is 400 revolutions per minute. It stands on a stone foundation without top-bracing.

2. Fig. 2119 is a machine of the circular order, made by H. B. Smith. They are made for 24″, 48″, and 60″ diameter saws. They can be made to center any lumber from $\frac{1}{4}$″ to 8″ thickness; or either side of the feed can be made unyielding so as to take off any thickness required. The rolls can be set on a bevel so as to take off feather edge or weather boards. The saw is guided in three places near its circumference; as it rises through the frame, by arms near the top, and below the top of the frame. The feed is by four rolls, to each of which power is applied.

3. Fig. 2120 is a band-saw resawing machine, by Fay & Co.

The saw-kerf is 1-16″. The wheels 5′ in diameter. The feed rolls are connected by expansion gears operated by friction. The machine will split stuff centrally or can be adjusted to saw off boards or panel stuff of any thickness.

Fay & Co. *"*Manuf. and Builder*," viii. 174.
Band-saw, *Richards & Co.*
*"*Min. & Sc. Press*," xxxiv. 193.
Circular, *Joslin.*
*"*Manufact. & Builder*," xii. 77.

Re-sec'tion In'stru-ments. (*Surgical.*) Osteotomy instruments, for the removal of the articular section of a bone or of the portions of a fractured bone of difficult apposition or false articulation.

The list includes bone-drills, periosteotome, subcutaneous, chain, or Hey's saws, bistouries, etc.

Res'er-voir. A chamber of supply as in —

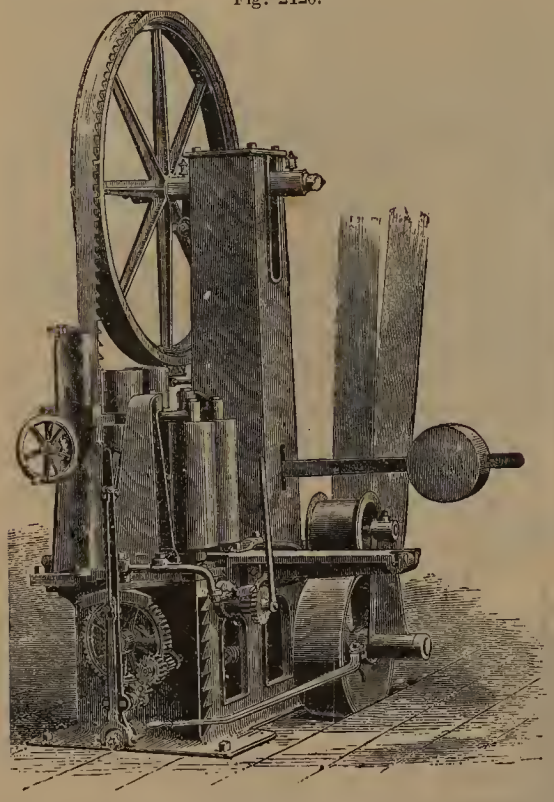
Reservoir stove; with a large boiler attached.
Reservoir blow-pipe, with air chamber. *Ross*, *"*Scientific American Sup.*," 4041.
Air-chamber for pumps; Fig. 24, p. 13, *supra.*
Air chamber for compressed air. *Siemens*, *"*Scientific American Sup.*," 2033.
Air chamber for rock drills. Plate X., p. 602, "*Mech. Dict.*"
Galvanic Batteries: See RESERVOIR BATTERY.

Res'er-voir Bat'te-ry. (*Electricity.*) One having a reserve of material, as in the case of those with vessels containing crystals of bichromate of potassium or sulphate of copper.

Res'er-voir Lev'el Re-cord'er. An instrument to indicate the fluctuations of the water in the reservoirs of water works. The drum performs a revolution once a week, being driven by a small turret timepiece, and the clock beats seconds. A friction clip in connection with the set dial enables the drum to be set to the true time.

The diameter of the drum is 12″, and its length is 3′, a fluctuation of 6′ being recorded, thus giving a scale of 6″ to a foot. This reduction of scale is thus obtained: The float pulley upon which the chain is fixed is double the circumference of the pulley which actuates the pencil, which is guided by the two horizontal brass bars over the top of the

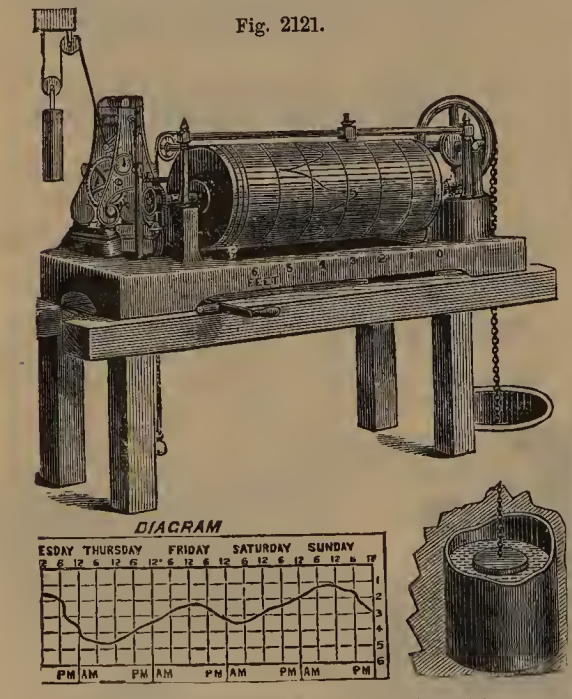
Fig. 2120.



Band Resawing Machine.

drum, in order to prevent any possible error from backlash of the mechanism, or by wear and tear in the ordinary course of use. The float is balanced by a small weight attached to a chain which is fastened to the pencil block; this enables a

Fig. 2121.



Bailey & Co.'s Reservoir Recorder. (*English.*)

very sensitive diagram to be taken. The illustration at the bottom of the engraving shows a portion of a diagram. See:

"*Engineer*" . . . . . xlv. 30.
*"*Scientific American*" . . . . . xxxviii. 130.

An electrical reservoir level recorder, used at Nottingham, England, is shown in—

"*Telegraphic Journal*" . . . . . * vii. 193.

Re-sid'u-al Mag'net-ism. (*Electricity.*) Magnetism which remains in the core of an electro-magnet after cessation of current. *Remanent Magnetism.* — *Ganot.*

Re-sist'ance. (*Electricity.*) The opposition presented by the metal composing the circuit, to the passage of the current.

Balance, *Fleming*, Br. . . * "*Engineering*," xxix. 15.
Coil, *Wheatstone* . . . . * "*Telegraphic Journal*," iv. 12.
Measurer, Differential.
Wheatstone . . . . . * "*Telegraphic Journal*," iv. 90.
Liquids, inst. for measuring,
Wheatstone . . . . . * "*Telegraphic Journal*," iv. 70.

Re-sist'ance He'lix. A member in a voltaic arc light apparatus, the duty of which is to preserve a constant regulated distance with the carbons.

The constant tendency is to an unequal action, inasmuch as the carbons burn away the positive much faster than the negative.

Such unequal action is remedied by the provision of a high resistance helix shunting the arc: through which current is diverted in proportion to the relative resistances of said high resistauce helix and of the arc; the energy of said high resistance helix always acting in opposition to that of said suction core. The resistance of said high resistance helix is so fixed that when the arc is of normal length the forces centered on the electrode movement are in equilibrium.

The two conditions of abnormal arc-length adjust themselves as follows: —

(*a.*) When the arc-resistance is below normal so little current is diverted through the high resistance helix that its energy is inappreciable and the suction core action is unopposed in its duty of lengthening the arc.

(*b.*) When the arc-resistance is above normal, the energy of the high resistance helix is increased sufficiently to overcome that of the suction-core and to reduce the arc to its normal condition. When this adjustment has taken place, the lamp in question resumes its normal resistance. Each lamp adjusting itself in the manner described ensures normal current-flow and equal illuminative action throughout the series.

Re-sist'ance Tube. Clerac's (of the French telegraph administration) tube is a wooden tube containing powdered carbon, with means for giving variability of resistance by compression, constituting a variable resistance rheostat.

* "*Telegraphic Journal*" . . . . vii. 52, 92, 121.

To Count du Moncel we owe the discovery, in 1856, of the variability of the resistance of powdered carbon; which seems to have its first practical application by Clerac.

The telephone transmitter of Edison depends on the same property.

Res'o-na-tor. 1. An invention of Helmholtz for facilitating the analysis of compound sounds.

See Fig. 4270, 4271, p. 1922, "*Mech. Dict.*"
See also . . . . . "*Manufact. & Builder*," ix. 132.
"*Scientific American*," xliii. 80.
* "*Scientific American.*" xxxvi. 263.
Brass wind instru., as . "*Scientific American Sup.*," 2112.

(*Add.*) 2. (*Surgical.*) The resonator which intensifies sounds of a given pitch while diminishing the distraction of others, has been applied to auscultation instruments.

Holden's resonator, Fig. 31, Supplement, *Tiemann's* "*Armamentarium.*"

3. A regulating apparatus in piano sounding-boards, which, by means of screws and iron frame, prevents the sounding-board (as a whole) from making transverse vibrations. — *Steinway, Paul's* "*Vienna Exposition Report*," i., Sec. B, p. 388.

Res'pi-ra'tor. A protector covering the mouth; a box furnished with fine gold-plated wire gauze to intercept dust, either in traveling or working in manufactories.

Watson's respirator, to enable the wearer to penetrate carbonic oxide, and other gases, left in collieries after explosions of fire-damp, contains a

Fig. 2122.

Respirator.

solution of caustic potash in a tube, as devised by Mitscherlich and modified by De Koninck. Air containing a dangerous proportion of carbonic oxide is fit for respiration after passing through the potash solution. A valve arrangement ensures inspiration of the cleansed air through the mouth, and expiration through the nose.

The Denayrouse respirator, to enable firemen to enter and remain in places filled with smoke or gas, consists of a tube, having inserted near one end a small tin case containing two peculiar India-rubber valves, — one for inhaling and the other for exhaling air. The end of this tube, which has a mouthpiece, is cast over the fireman's shoulder, the other being left in the open air; and an India-rubber spectacle mask, capable of being molded to fit any features, having been placed over the eyes so as to compress the nostrils, the fireman may enter without fear the most vitiated atmosphere. See also Fig. 4272, p. 1923, "*Mech. Dict.*," in which the fireman carries a sack of vital air.

See also Galibert's apparatus, Fig. 2677, p. 1185, *Ibid.*

See also AËROPHORE, Fig. 17, p. 8, *supra.*

Fireman's . . . . . "*Scientific American Sup.*," 1111.
Respirator, for engineers * "*Engineer*," xlvi. 293.
in tunnels, *Galibert*, Fr. "*Scientific American*," xxxviii. 99.
Ronquayrol . . . . * "*Scientific American*," xxxviii. 99.
Respirator for reduction works . . . . . * "*Min. & Sc. Press*," xxxviii. 249.
Schultz, aërophore . . * "*Scientific American*," xxxviii. 99.
High pressure aërophore * "*Scientific American*," xxxviii. 99.
Respiration of plants.
Deherain & Vesque . * "*Scientific American*," xxxvi. 70.

See also INHALER, p. 1184, "*Mech. Dict.*"

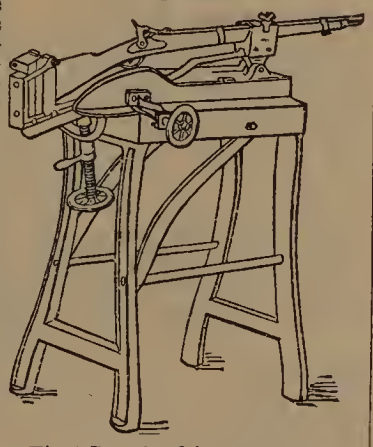
See also RESPIROMETER, *infra.*

Res-pi-rom'e-ter. The name adopted by Mr. Fleuss for his diver's apparatus for supplying air to a person beneath the surface of the water.

It is a modified form of diver's dress and helmet. The latter, which is no larger than that ordinarily used, has a close circular chamber of about ¼ cubic foot capacity, and in this is stored a supply of oxygen under a pressure of 240 pounds per square inch, from a suitably charged reservoir. This affords him sufficient air-food for about five hours. The expired air from the lungs is passed, by means of a flexible tube, to a closed receptacle of vulcanite, which is attached to the yoke-piece carrying the usual rubber dress, which receptacle is filled with spongy rubber saturated with caustic soda. The expired breath is filtered through this soda, which absorbs every trace of carbonic acid, and allows the nitrogen to pass. The air in the diver's lungs and about his somewhat capacious clothing when he first puts on his suit, contains nitrogen enough for indefinite use, and is used again and again to dilute the oxygen, as the latter is constantly supplied from the compressed store in the helmet.

See also *RESPIRATOR, p. 1923, "*Mech. Dict.*"

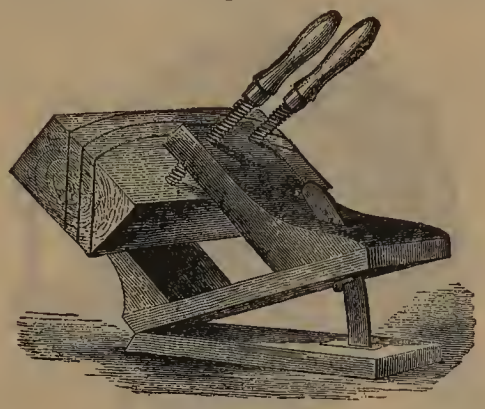
Fig. 2123.



Fixed Rest for firing small arms.

Rest. 1. A support for a gun in test-firing. See Fig. 2123. The design is to ascertain the actual accuracy of the piece, in ball-firing; or, in the case of shot-guns, the number of pellets of a given size, which strike a target of a given area, the piece being at a stated distance. A certificate of the firing of each barrel is furnished with all first-class guns.

Fig. 2124.



Rest for Bevel-cutting with Band-saw.

2. A support or a guide for stuff fed to a saw.

Re-tain'ing Ring. (*Railway.*) A metallic ring which secures the wheel-center to the tire.

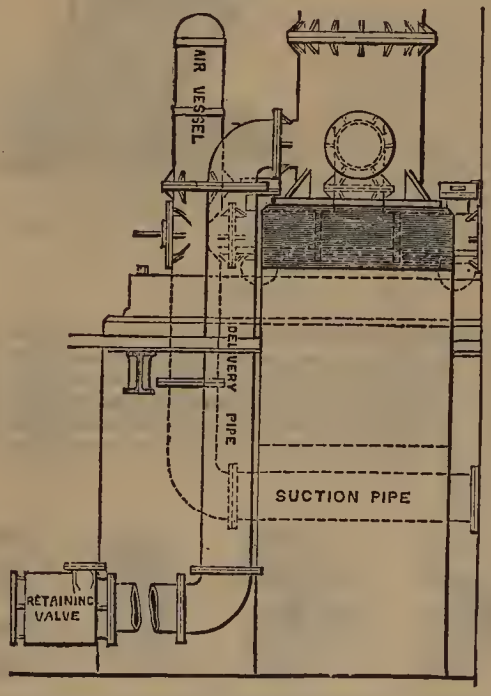
Fig. 2125.

Foot Valve of Pump.

Re-tain'ing Valve. A check-valve, to prevent reflux of water or steam. Placed sometimes at the bottom of a pump-stock to prevent water leaving during cessation of pumping. Fig. 2125 shows a retaining valve for deep well-pumps.

Fig. 2126 shows the position of a retaining valve placed near to the air-vessel of a heavy pumping engine to prevent any water leaking back through the pumps when the engine is stopped. It also admits of the pumps being examined without emptying the up-take.

Fig 2126.



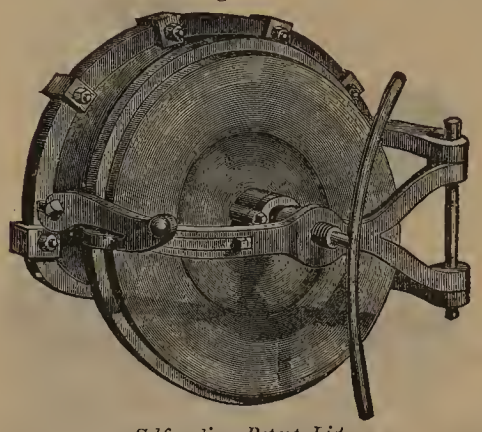
Retaining Valve in relation to Delivery Pipe.

Re-tort'. Retorts for the laboratory, gas works, mercury distillation, for silver amalgam, and dis-

tillation of acids are mentioned in * pp. 1924, 1925, "*Mech. Dict.*"

Fig 2127 is an illustration of a self-sealing gas retort for gas works. The lid is secured by a central screw plug to a

Fig. 2127.



Self-sealing Retort Lid.

hinged frame, which also carries a latch-bar. The lid being swung shut and latched, the screw plug is rotated by the lever handle to tighten the closure of the lid and prevent leakage of gas.

Furnace . . . . . "*Am. Man.*," Sept. 12, 1879, p. 12.
Price . . . . . * "*Eng. & Min. Jour.*," xxi. 156.
Self-sealing lid, *Collinson* * "*Am. Gas Light Jour.*," July 3, 1876, p. 14.
Retort settings . . . * "*Scientific American Sup.*," 1551.
Retort setting, gas . . * "*Scientific American Sup.*," 678.
Retort stoking machinery.
Rowland, Br. . . . * "*Engineering*," xxiv. 182.
Retorts, vertical, distilling shale, *Rennie*, Britain * "*Scientific American Sup.*," 904.

Re-touch'ing Frame. A desk with glass pane on which a negative or positive is placed and viewed by transmitted light in order to repair defects, soften shadows, etc.

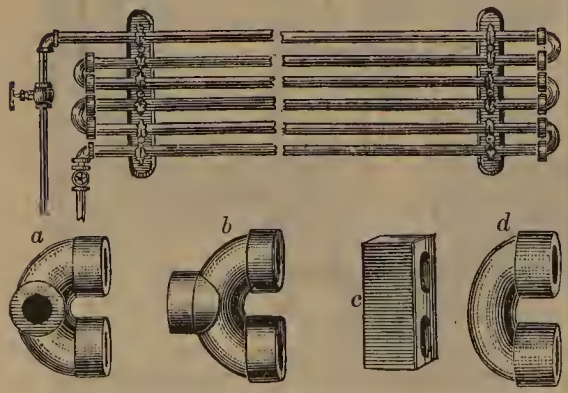
Fig. 2128.

Retouching Frame.

The pane *A* has a ground-glass shade, *B*, and a mirror, *C*. The stand *D* has drawers for pencils, paint, and brushes. *E* is a sliding-board as a hand-rest.

* "*Scientific American*" . . . . . xxxvi. 226.
"*Scientific American Sup.*" . . . . 2211.

Fig. 2129.

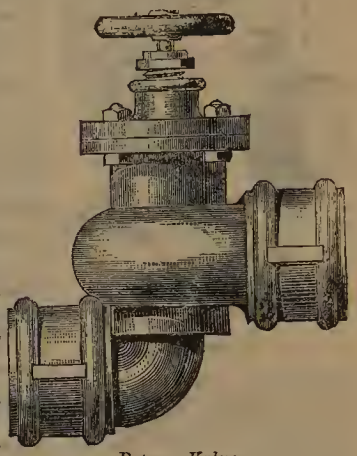


Radiator for Wall, with Return Bends and Coil Plates.
Return Bends.

a. Side-outlet return bend.
b. Back-outlet return bend.
c. Square return bend.
d. Ordinary return bend.

Re-turn' Bend. A U-shaped pipe coupling for uniting the ends of pipes. It may be *open* or *closed;* in the former the branches being some distance apart, as in the letter U. See Fig. 2129.

Fig. 2130.



Return Valve.

Re-turn' Valve. A valve in a main or pipe having two functions; one as a reflux or back-pressure valve to prevent the return of the contents of the pipe; the other condition is when the valve is raised by the screw spindle to allow the re-flow of the contents. Also called an *end* valve. See also REFLUX VALVE, *supra.*

Re-ver'ber-a-to-ry. A furnace with domed ceiling which reflects the flame and heat downward upon the metal on the hearth. See Fig. 4283–4286, pp. 1926, 1927, "*Mech. Dict.*"

* *Laboulaye's* "*Dict.*," "*Combustible*," Fig, 559–560.
Furnace, *Cassel* . . . * "*Iron Age*," xx., Nov. 1, p. 5.
Chisholm . . . . . * "*Iron Age*," xvii., April 6, p 5.
Kirk . . . . . * "*Iron Age*," xxi., March 7, p. 5.
Morrison . . . . . * "*Iron Age*," xx., Nov. 8, p. 5.
Nichols . . . . . * "*Iron Age*," xx., Nov. 15, p. 5.

Re-verse' Jaw Chuck. One with jaws capable of inversion in the face plate to enable it to grasp upon the exterior or interior of the object. Instances under LATHE CHUCK, pp. 528, 529, *supra.*

Re-ver'si-ble Com-pres'sor. (*Microscopy.*) A form of slide with compressor which is capable of inversion to expose either side of the object.

Re-ver'si-ble Saw. A bow saw with a blade each edge of which is toothed, and either capable of being presented in working attitude.

Re-ver'si-ble Boil'er. One on trunnions, so as to alternate ends, removing scale by bringing the end at which sediment has collected to the action of steam in the new position.

Re-ver'si-ble Street Car. (*Railway.*) A street car mounted on its running gear so as to swivel thereon and turn end for end, dispensing with a turn-table.

Re-vers'ing Cyl'in-der. In the Westinghouse air brake arrangement. A small cylinder placed in the steam cylinder head and in which the reversing piston works.—*Forney's "Car Builder's Dictionary,"* Figs. 665–683.

Re-vers'ing En'gine. While all locomotives have facility for reversing steam, the term reversing is particularly applied to such engines as have but lately been fitted to run at will in either direction.

Such are rolling mill engines intended to pass a loop or bar back and forth between the same rolls, which are run in one or the other direction alternately. See ROLLING MILL ENGINE.

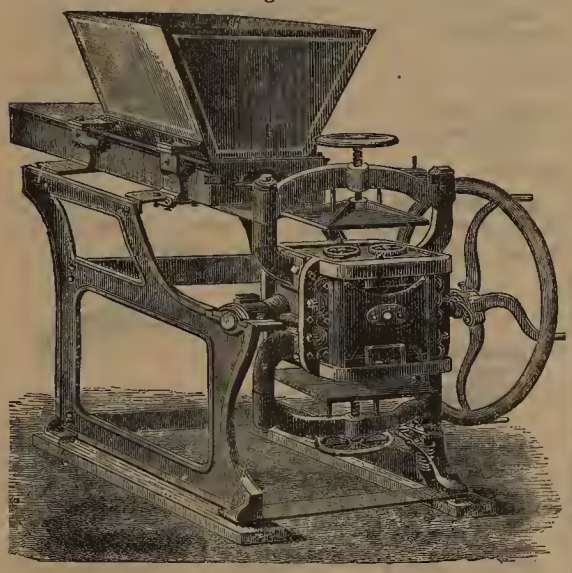
* "*R. R. Gazette*," xxiii 386, 398.
* "*Scientific American Sup.*," 2163.

Launch engine.
Tipping, Br. . . . * "*Engineer*," l. 165.
Rolling mills,
Claridge, Br. . . . * "*Engineering*," xxix. 285.
Steam. *Stirling* . . . * "*Scientific American*," xxxiv. 98.
Link for steam engine.
Smith . . . . . * "*Van Nostrand's Mag.*," xxi. 123
Rolls, Friction clutch for
Kloman . . . . . * "*Iron Age*," xxi., June 6, p. 1.

Re-vers'ing Ma-chine'. (*Founding.*) A form of molding machiue iu which the flask is carried ou trunnions so as to be tipped over and the saud rammed from either side.

The operation is as follows: The patterns and followers being properly adjusted, the drag part of the flask is placed on top of sand box; the bridge piece of drawer bottom is let down, when it makes connection between the hopper and flask; the drawer is then pulled out with the sand, dropping it into the flask; then the drawer is taken back into the hopper; the bridge piece is then raised, the binder bar is brought over and fastened down on flask; then the power is applied

Fig. 2131.



Reversing Machine.

which forces the patterns and follower with the sand up into the flask; then the part of the machine with flask on is turned over in its trunnions, thus bringing the flask to lower side of machine with mold up; the power is again applied, which draws the patterns up, leaving the mold complete; the binder is loosened, which leaves the flask resting on the binder plate, which is then swung out and the flask carried away. The cope part of flask is then molded in a similar manner, but taken off from the top.

Re-vert'ing Flue Boil'er. One in which the gaseous products revert on their former course; traversing twice through the boiler, iu distinct and successive series of flues.

An instance is shown in Fig. 5638, p. 2329, "*Mech. Dict.*"

Re-vet'ment. See definition of varieties, p. 1928, "*Mech. Dict.*"

Among the forms of revetment for preventing the erosion of river banks may be mentioned the following: The woven brush revetment, the continuous mat, or brush blanket, made of brush, sewed together with wire, and the willow screen made by laying the willows as nearly as possible in juxtapositiou and securing them with wire.

The manner of using either of these devices is the same. The bank to be protected should first be graded to a slope of about 2 upon 3 or less, an operation that can be very cheaply performed by the use of hydraulic force-pumps, after which the revetting should be put on so as to extend from the ordinary high-water limit down the bank and out along the river-bed sufficiently far to protect the slope should any unusual scour take place. The total width is usually in the neighborhood of 100′ on the lower Missouri. To sink that portion which is under the water, a small quantity of rock is sometimes necessary, but usually the current itself and the sediment that collects on the brush will suffice for this. See plate opposite p. 1455, "*Report of United States Engineers*," 1880.

Canal bank revetment, *Ibid.*, 1876, vol. ii., part 2, Plate V., p. 417.

(*Hydraulic Engineering.*) For view aud description of the building of the revetment mattress at Council Bluffs on the Missouri River. See "*Report of the Chief of Engineers, U. S. Army*," 1880, * ii. 1436.

Re-vol'ver. For history and varieties, see pp. 1928-1930, "*Mech Dict.*"

Fig. 2132 is the latest Smith & Wesson revolver with automatic discharge of the spent cartridge capsules. The discharge is moved rearward by the rocking of the barrels on

Fig. 2132.

Revolver.

the hinge to uncover the breach, and throws the capsules clear of the barrels. The discharger then returns automatically into place.

The bull dog revolver is a pocket weapon with short barrel and large bore.

For revolving ordnance see MACHINE GUN, *supra.*

Colt. * *Adams.*
Devisme. *Lefaucheux.*

Article "*Revolver*," *Laboulaye's* "*Dict. des. Arts et Manufactures*," iv., ed. 1877.

See also *Martin's* patents 222,065, 220,066.
Wesson's . . . . . 222,167, 222,168.
Schofield's . . . . 227, 449.
Revolver factory.
Smith & Wesson . . * "*Scientific American*," xlii. 47.
Revolving cannon.
Hotchkiss . . . . . * "*Engineering*," xxvii. 3, 23, 25, 63.

Re-volv'ing Boil'er Steam En'gine. The invention of Fred. Siemens, of Dresden. It has no valves nor pistons. The boiler itself revolves, and from it power is trausmitted to the machinery to be driven.

"It consists of a steam-boiler of approximately cylindrical form, carried on an inclined axis about which it rotates. Inside this boiler is a worm or screw composed of sheet-metal, and having such form that each portion of the screw having a length equal to its pitch, closely resembles a funnel which has been slit down one side and slightly separated to unite with others above and below it.

"The lower portion of the boiler has a double bottom, and the upper is surrounded by a spiral of gas-pipe, having a direction the reverse of the funnel-like spiral below.

"Water is placed in the lower portion of the boiler and in the space between it and the external jacket, a communication being established between them by means of small holes.

"Surrounding the whole lower portion of the apparatus is a jacket of non-conducting material, and between it and the boiler is a space through which circulate the gases from the furnace, or, in this case, from the gas-burner by which it is heated, passing off by a small chimney at its upper end.

"The heat being applied, steam is formed, which rises through the water, impinging on the immersed funnel-like spirals, producing a tendency to rotatiou. Above the water it enters the helix of gas-pipe, and, condensing, flows back into the boiler, its reaction causing further effort to rotate the boiler.

"The boiler being once filled, requires no further attention, as there is no loss of the liquid." — *Vienna Report.*

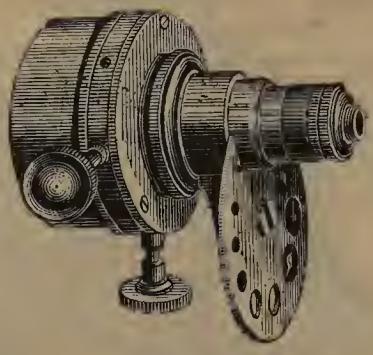
Re-volv'ing Can'non. See MACHINE GUN, Figs. 1647, 1649, pp. 569, 570, *supra.*

Report on trial of the Hotchkiss revolving cannon, in "*Ordnance Report*," 1877, Appendix O, p. 609 *et seq.*, with 4 plates, and *Ibid.*, Appendix I^4, 1879, p. 143, *et seq.*, with 17 Plates.

Report on trial of the Gatling gun 45″ (English model), *Ibid.*, 1879. Appendix I^{12}, p. 190 and 15 plates.

Re-volv'ing Di'a-phragm. (*Optics.*) The diaphragm is used in optical instruments to exclude some of the marginal rays of a beam of

Fig. 2133.



Revolving Diaphragm.

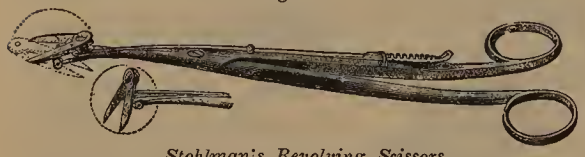
light. It is a means of contracting the aperture. The revolving diaphragm has a number of apertures of varying sizes, either of which can be brought coincident with the optical axis of the instrument.

Re-volv'ing Scis'sors. (*Surgical.*) An instrument for deep operations in cavities of the body.

The blades revolve upon their own axis as shown by the dotted lines. The blades can be presented anteriorly, posteriorly, or laterally.

The blades being short and firm, will cut strong or delicate tissues The rotation of the blades is produced by the in-

Fig. 2134.



Stohlman's Revolving Scissors.

dex finger of the same hand which operates. By depressing the lever near the handles and sliding it forward or backward, the scissors are placed in any required position, and held firmly by allowing the lever to snap into one of the notches; in the same manner the position can be constantly changed at pleasure.

Re-volv'ing Scra'per. A road scraper which revolves completely on its axis; not merely tipping. Fig. 4695, p. 2058, "*Mech. Dict.*"

Re-volv'ing Head-saw Ma-chine'. A screw-cutting machine which contains a number of dies on a head which can be revolved so as to bring either to the work.

Fig. 4734, p. 2067, "*Mech. Dict.*"
A Turret Cutter, Fig. 6824, p. 2665, *Ibid.*

Re-vul'sor. (*Surgical.*) An apparatus to apply heat and cold alternately as a therapeutic agent.

McLane's revulsor has two vessels containing hot and cold water, which are passed along the spine or over a paralytic muscle so as to succeed each other rapidly. — *Philadelphia "Medical Times,"* * Sept. 4, 1875.

Rhe'a Fi'ber Ma-chine'. For operating upon the China grass, Malay *ramie*, the *Bœhmeria nivea*. See Ramie Machinery.

Greig, Br. . . . . * "*Engineer*, xliv. 387.

Rhé E-lec-trom'e-ter. A device by Mariani to investigate electrical discharges between the atmosphere and the earth.

It has a copper wire coiled upon a pasteboard tube, and carrying a traversing magnetic needle upon a pivot above the coil. A small iron bar is inserted axially within the coil. The apparatus is placed with the coil east and west. A spark of high tension passing through the coil magnetizes the bar, which deflects the needle east or west, according to the spark's direction. The iron bar must be de-magnetized by heating before using again.

"*Scientific American*" . . . . . xxxiv. 303.
* "*Scientific American Supplement*" . . 456.
de Vos, "*Telegraphic Journal*" . . . iv. 108.

Rhe'o-phore. (*Electricity.*) An electrode.

Rhe'o-stat. (*Electricity.*) An instrument for regulating the current, by offering more or less resistanee to its passage. See Fig. 4311, p. 1934, "*Mech. Dict.*"

Butler . . . . . * "*Scientific American*," xli. 147.
Carbon, *Edison* . . . "*Telegraphic Journal*," vi. 408.
"*Scientific American*," xxxv.
Groves . . . . . * "*Telegraphic Journal*," iv. 172.
* "*Scientific American Sup.*," 574.
Machine, *Planté* . . . * "*Telegraphic Journal*," v. 309.
Wheatstone . . . . * "*Telegraphic Journal*," iv. 10.
* "*Scientific Amer.*," xxxix. 296.
Machine . . . . . * "*Scientific Amer.*," xxxviii. 169.

Rhi'no-plas-tos. A species of flat nosed pinchers for straightening the bones of the *septum narium* deformed by accident or violence.

Fig. 2135.

Dr. Adams' Rhinoplastos.

Rhinoscope . . * "*Scientific American Sup.*," 1722.
"*Mech. Dict.*," p. 1935.

Rib. (*Add.*) 7. (*Fire-arm.*) One of the plates above and below, which connect the two tubes, forming the double barrel.

Ribbed Boil'er. One with corrugations or projecting ribs to add to the surface exposed to the fire. Used for greenhouse boilers.

Rib Fab'ric Ma-chine'. A knitting machine adapted to make the rib stitch. It has peculiar adjustments in the power and hand machines, and in some has various capabilities, for making *polka rib*, *one-and-one rib*, etc.

See description by Mr. G. W. Gregory, "*Centennial Exhibition Reports*," Group XXII., vol. vii., pp. 53-59.

Rib Shears. (*Surgical.*) See Costotome.

Rib'-top Ma-chine'. A knitting machine adapted to make rib-tops of hosiery; with, in some cases, an adaptation to make broad-rib hose throughout.

One by Gisuson and Coltman, of Leicester, England, was shown at the Centennial, capable of making from 200 to 250 dozen pairs of tops per week of 60 hours.

It is arranged to make rib tops with welt and slack course, and is fitted with three carriers; also a pattern wheel, which can be altered at pleasure to make any pattern. The length of top can be varied as desired, and the self-acting winding tackle for receiving the work is as effective as it is simple, only requiring the work of a few moments to take off the fabric and proceed with further productions. This machine can be changed in action, whilst running, to make the royal rib stitch; it will also make the two-and-one rib socks, with welt; it can be worked by steam or by hand. A dial indicating the amount of work done is supplied.

When making broad-rib hose a cylinder pattern wheel is fitted, and this is so adapted that the patterns can be varied through the whole length of hose. It will make 36 dozen pairs of hose legs in the week of 60 hours.

Rice Drill. A force-feed machine for drilling rice. See Grain Drill, Wheat Drill, "*Mech. Dict.*"

Rice machinery . . . "*Scientific Amer.*," xxxvii. 137
Huller . . . . . "*Scientific American Sup.*," 1510.
Decorticator, *Coromandel* "*Technologiste*" xli. 364.

Ridge Har'row. (*Agric.*) One hinged longitudinally so as to be capable of lapping upon the sides of a ridge over which it passes. Fig. 1318, p. 440, *supra.*

Riepe Steel. (*Metallurgy.*) Steel made by a process of adding to a bath of pig-iron in a reverberatory, iron-slag, salt, clay, and oxide of manganese. The iron is worked below the scum and rolled into balls for the shingler.

Rif'fle Blocks. (*Mining.*) Wooden blocks set on end in a sluice with interstices for catching gold.

Ri'fle. A fire-arm with barrel grooved spirally to give a rotation on its axis to the projectile.

See history, pp. 1939-1943, "*Mech. Dict.*," and illustrations of —

* *Sharps.*
* *Maynard.*
* Creedmoor rifle range.

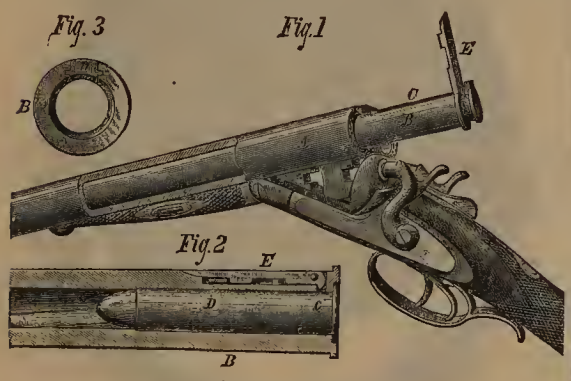
See also FIRE-ARM, pp. 850–860, where are illustrations of

Martini.
Prussian needle gun.
Merrill.
Laidley.
Snider.
Peabody.
Allen.
Sharps.
Chassepot.
Maynard.
Spencer.
Berdan.
Richards.
Roberts.
Hall.
Burnside.
Puckles.
Elliot.
Springfield.
Ward-Burton.
Remington.
Dodge.
Swiss.
Winchester.

See also REVOLVER.

Fig. 2136 shows Stevens' plan for converting a shot-gun to a rifle by slipping a rifle barrel into that of the shot-gun.

Fig. 2136.



Converting Shot-gun to Rifle.

Fig. 1 is a perspective view.
Fig. 2 is a longitudinal section.
Fig. 3 shows the breech of the rifle (enlarged).

The rifle-barrel *B* slips into the rear end of the shot-gun barrel *A*, the flange formed on the end of it occupying the recess made in the shot-gun barrel for the reception of the flange of the cartridge. The rifle barrel has a longitudinal recess for receiving the slide *D* on which is pivoted a lever *E* having at its rear end a short projection, *C*, extending inward.

After the discharge the barrel of the gun is tilted down, and the extractor starts the rifle barrel out of the shot gun barrel; this operation moves the slide *D* slightly, and starts the cartridge shell. Should this prove insufficient the rifle barrel is drawn out far enough to admit of raising the lever *E*, which operation moves the slide *D* and ejects the shell.

Statement of the number of machines, fixtures, small tools, and gages necessary for the manufacture of 200 Springfield rifles per day of 10 hours: —

Names of Parts of Rifle.

Barrel.	Cam latch.
Receiver.	Thumb piece.
Breech screw.	Firing-pin.
Breech block.	Extractor.
Breech-block cap	Extractor spring spindle.
Guard plate.	Cap with 2 rivets.
Guard bow.	23 screws for parts.
Trigger.	5 springs.
Butt plate.	2 pins.
Lower bands.	2 studs.
Upper bands.	2 washers.
Lower band-springs.	Stock.
Upper band-springs.	Lock plate.
Upper band swivel.	Hammer.
Guard bow-swivel.	Main spring.
Ramrod.	Sear.
Ramrod stop.	Sear spring.
Tip.	Main-spring swivel.
Front sight.	Tumbler.
Rear-sight base.	Bridle.
Rear-sight spring.	Hinge pin.
Rear-sight leaf.	Bayonet.
Rear-sight cap.	Bayonet clasp.

	Cost.
37 machines for making the stock	$60,000
81 machines for making the barrel	54,000
51 machines for making the receiver	23,500
17 machines for making the breech screw	6,600
37 machines for making the breech block	13,100
5 machines for making the breech-block cap	1,500
12 machines for making the cam latch	5,600
10 machines for making the thumb piece	3,800
3 machines for making the firing pin	1,060
9 machines for making the extractor	2,950
1 machine for making the extractor spring spindle	425
14 machines for making the guard plate	4,800
9 machines for making the guard bow	2,900
11 machines for making the trigger	3,600
13 machines for making the butt plate	5,400
10 machines for making the upper and lower bands	5,300
10 machines for making the upper and lower springs	3,300
10 machines for making the upper and lower swivels	3,000
7 machines for making the ramrod	2,570
8 machines for making the ramrod stop	2,735
5 machines for making the tip	1,535
4 machines for making the front sight	1,565
18 machines for making the rear sight base, and spring	6,650
34 machines for making the rear-sight leaf, cap, and pins	15,070
15 machines for making the lock plate	6,100
16 machines for making the hammer	5,800
12 machines for making the main spring	3,490
8 machines for making the sear	2,750
7 machines for making the sear spring	2,050
4 machines for making the main-spring swivel	1,225
12 machines for making the tumbler	4,500
8 machines for making the bridle	2,730
4 machines for making the hinge-pin	1,300
46 machines for making the bayonet	19,575
8 machines for making the bayonet clasp	3,370
13 machines for making screws, pins, and studs	6,120
18 polishing machines, stands, wheels, etc.	2,200
51 forging machines, drop hammers, and presses	39,000
2 sets of forging dies	22,000
18 water-front forges	2,700
4 annealing furnaces	1,600
2 hardening furnaces	1,000
2 blowers (fan blowers)	400
2 sets of gages, 1 working and 1 inspection set	45,000
1 set of fixtures and 2 sets of small tools	115,000
32 machines for tool-making, repairing, etc.	13,600
696 Total for machines, tools, and gages	$532,770

For running the above machines and tools it would require a condensing engine of 32″ × 60″, 300 horse-power; 4 tubular boilers, 16′ × 5′; 2 tubular boilers, 16′ × 5′, reserve. Cost about $25,000.

Floor-space occupied by using all above machines, tools, etc., 125,000 square feet.

Compiled for this work by C. J. EHBETS, of Hartford, Conn.

Breech loading, *McAlpine* * "*Scientific American*," xxxix. 230.
Browne & Sharpe, Shops * "*Scientific American*," xli. 271.
Greener, Br. * *Laboulaye's* "*Dict.*," iv., "*Armes à Feu.*"
Hair-trigger, *Leonard* * "*Scientific American*," xxxv. 325.
Hammerless * Fig. 1298, p. 432, *supra.*
Hammerless, *Greener*, Br. * "*Scientific American*," xliii. 274.
Martini-Henry "*Iron Age*," xx., Aug. 30, p. 1.
Military * "*Scientific American Sup.*," 74.
Military, French service.
Gras * Fig. 1028, p. 335, *supra.*
Needle, *Pieri* * "*Engineer*," xlv. 334.
* "*Scientific American Sup.*," 2086.
Repeating, French "*Van Nostrand's Mag.*," xx. 449.
Repeating, French navy (20 Figs.) * "*Engineer*," xlvii. 223.

Revolver	See *infra.*
Rifling cannon, on	
Zalinski	"*Scientific American Sup.*," 410.
Shot-gun	See *infra.*
Soper, Ger.	* "*Engineer*," xlv. 35, 46.
	* "*Scientific American Sup.*," 1825.
Steyer, Austria . .	"*Iron Age*," xxiv., Sept. 18, p. 15.
Whitworth	"*Van Nostrand's Mag.*," xiv. 199.

"*Report of Chief of Ordnance U. S. Army*," 1877, has descriptions and drawings of the following foreign small arms. See Appendix L: —

Werndl	Figs. 101, 102, pp. 537-570.
Tabatière	Fig. 91, p. 558.
Snider	Fig. 92, p. 558.
Kruka	Fig. 93, p. 558.
Albini-Brandlin . . .	Fig. 94, p. 559.
Martini-Henry . . .	Figs. 97 to 97*w*, p. 560.
Werder	Figs. 100 to 100*p*, p. 568.
Turnurth	Fig. 104, p. 572.
Vetterlin	Fig. 105, p. 573.
Mauser	Fig. 106, p. 575.
Chassepot	Fig. 107, p. 577.
Russian	Fig. 108, p. 580.

See also Breech Loader; Magazine Gun; Hammerless Gun: Needle Gun, Revolver, etc.

Ri'fling Ma-chine'. A machine for making the spiral grooves in the barrels of guns.

As used in the U. S. armories it is a machine in which the barrel is firmly held while a mandrel carrying a cutting tooth is drawn through it, the mandrel making one and a half revolutions during its passage through the barrel. The barrel makes a third of a revolution between each cut, and the result is a barrel with three *grooves* and three *lands*. The groover is worked automatically, expanding to make the groove deeper as it repeats the cut in the same place, until the groove is deep enough. The barrel is drenched with oil all the time.

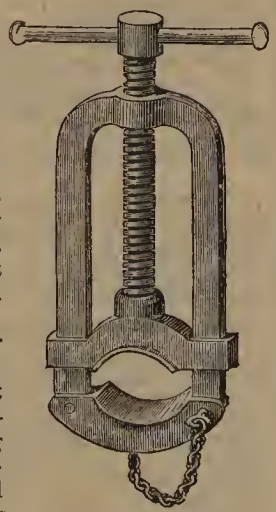
The Pratt & Whitney rifling machine gives from one turn to the grooves in 20″ to one in 36″. The cutter-rod carries from 1 to 3 cutters, as the rifling is 4, 5, or 6 to the circumference. An adjustable feed-stop gages the depth of the rifling, and the racks, which are of steel, are double, to take up all back-lash, so that the cutters cannot ride on the lands. An oil-pump feeds automatically at each end of the stroke. The carriage is gibbed on the outside of the long slide, allowing free access to its working parts.

Rig'ging Cut'ter. An apparatus invented to cut the rigging of sunken vessels as a means of removing the masts, etc., which form an impediment to navigation.

"Grosser Kurfurst" . . . * "*Engineer*," xlviii. 375.

Rig'ger Screw. A clamp for setting up shrouds and stays, one portion being made fast, the part to be hauled taut is lashed to the other, and the parts then approached by means of the screw.

Fig. 2137.



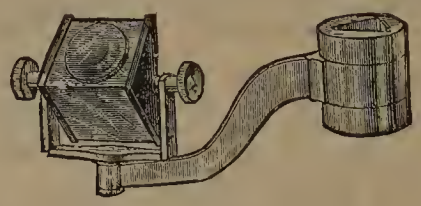
Rigger Screw.

Rig'ging Stop'per. (*Nautical.*) A hold-fast or preventer-rope acting as substitute when a shroud or stay is shot away or stranded in a gale. It may have a knot and ianiard at each end, or dead-eyes and tails.

Right-and-Left Coup'ling. A turn-buckle. The link having right-and-left nuts at either end, rods inserted are drawn together or apart by rotation of the link. See Turn-buckle, Fig. 1694, p. 2659, "*Mech. Dict.*"

Right'an-gle Prism. (*Optics.*) An attachment to the microscope stand for throwing light upon an object. It is rotatable on its horizontal axis, and also on a vertical axis, in order to direct the light in the requisite direction.

Fig. 2138



Achromatic Right-angle Prism.

Rig'id Sus-pen'sion Bridge. A bridge with catenary suspension members, of such form and so braced as to form an unyielding truss.

See Paper by *Fuller* . . * "*Engineering*," xxi. 183.

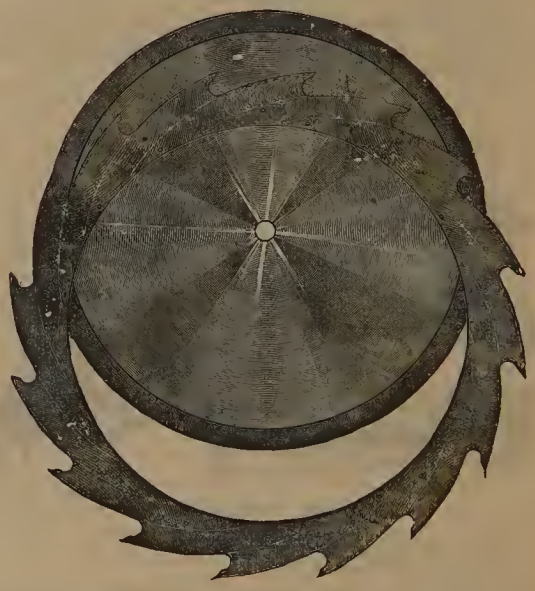
Rim Pla'ner. A machine for dressing the rims of carriage-wheels.

See Rim-planing Machine, Fig. 4330, p. 1944, "*Mech. Dict.*"
Felly Planer, Fig. 1016, p. 331, *supra.*
Felly Dresser, Fig. 1940, p. 832, "*Mech. Dict.*"

Rim Saw. A saw the cutting portion of which is annular and mounted upon a central circular disk.

See also Ring Saw, *infra.*

Fig. 2139.



Rim Saw.

Ring Boot. (*Manége.*) A caoutchouc or rubber ring on the fetlock to induce the horse to travel wider and prevent interfering. See Interfering Strap, Fig. 2089, p. 1192, "*Mech. Dict.*"

Ring Bush. A socket with anti-friction rings on its interior perimeter, as in some descriptions of rope blocks. See Fig. 263, p, 119, "*Mech. Dict.*"

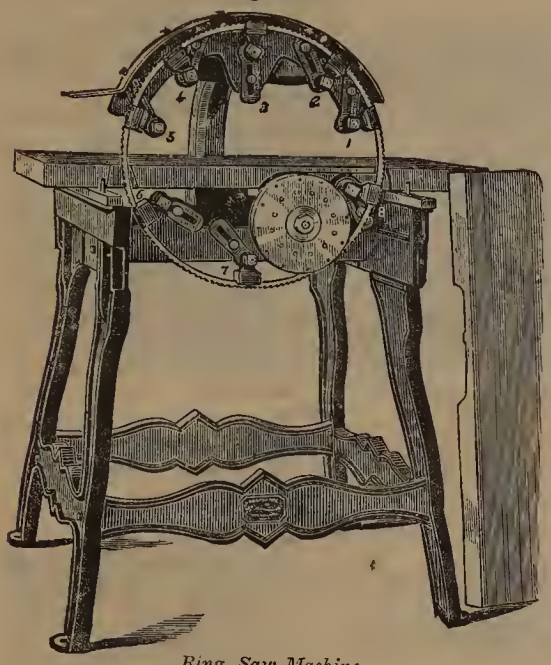
Ring Mal'let. One the head of which is strengthened by rings driven upon it. See *y*, Fig. 3032, p. 1379, "*Mech. Dict.*," where are also shown other forms.

Ring Plate. A ring in a plate attached to a wall to support a steam radiator pipe or coil. See Coil Plate, Fig. 656, p. 208, *supra.*

Ring Saw. A narrow cylindrical saw with serrated edge running upon guides which strain it and keep it in circular form.

It is a form of scroll saw. The clearance is effected by setting the teeth or making the blade thinner towards the back.

Fig. 2140.



Ring Saw Machine.

The inside of the saw fits into a groove on the driver which revolves the saw, so that the greater the amount of work on the saw, the tighter the friction holds it; and when the saw is not at work, the friction is only sufficient to revolve the saw. On the opposite end of the driving shaft from the friction wheel are two pulleys, tight and loose, to receive a 2½″ driving belt. The saws can be used from ¼″ to 1″ wide.

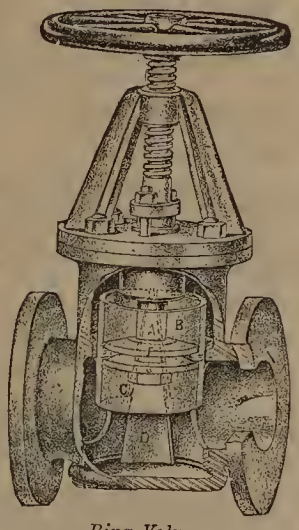
See Fig 4334, p. 1945, "*Mech. Dict.*" See also RIM SAW, *supra*.

Ring Splice. (*Nautical.*) A loop made in a rope by splicing the end to the standing part as in *f*, Fig. 5435, p. 2279, "*Mech. Dict.*"

Ring Top Fur'nace. A charcoal furnace for smoothing irons, etc., having an annular top and cross bars, removable at pleasure.

Ring Valve. A valve of cylindrical shape sliding in a chamber which has a similar form but has apertures which afford a through way when the valve is lifted.

Fig. 2141.



Ring Valve.
A. Valve stem.
B. Ring valve.
D. Wedge.

The valve has a vertical slit on one side and is expansible as the screw forces it down upon a wedge which occupies an axial vertical position within it.

Rins'ing Ma-chine'. 1. A centrifugal machine in which clothes from the rinsing tub are placed in order to remove the water as far as possible by mechanical means, before placing the clothes in the drying closet. See LAUNDRY, Plate XXV., opp. p. 532, *supra*.

2. A machine for passing calicoes, etc., through water to remove superfluous color, etc., acquired in the dyeing or bleaching processes. Fig. 4336, p. 1945, "*Mech. Dict.*"

Rip'-Rap. Loose stone pitched around a subaqueous foundation to prevent erosion by water

Many of the most important railroad bridges have their piers founded on timber cribs filled in with stone, the timber work being carried up to within a couple of feet of lowest water mark before starting the masonry. On bottoms subject to erosion, a plentiful supply of rip-rap is dumped around the foundation and replenished from season to season till well solidified.

This is the usual system in America when the river bottom is of such a nature that a solid bearing on stone, hard-pan, or gravel can be insured. When a soft material overlies a hard bottom, loose stone, *rip-rap*, is thrown in to form a foundation for the crib work or masonry.

Riv'et. A short bolt the end of which is swaged to prevent retraction.

Fig. 2142.

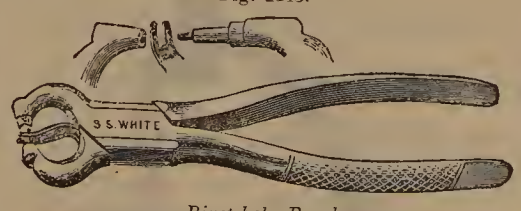
Rivets.

Fig. 2142 shows a number of forms, the greater number of which are distinguished by the shapes of their heads.

Riv'et Clip'per. A tool like a bolt cutter for clipping the superfluous length of rivets before swaging the end. Fig. 4346, p. 1947, "*Mech. Dict.*"

Riv'et-hole Punch. (*Dentistry.*) A hand tool used in perforating dental plates for the reception of rivets.

Fig. 2143.



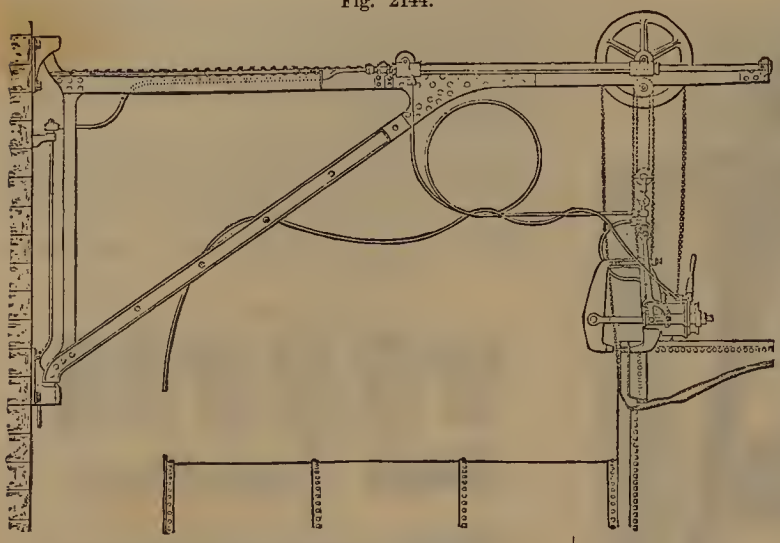
Rivet-hole Punch.

Riv'et-ing Bur. A washer placed on a rivet and upon which the end is swaged down. Used only in small affairs, from 1-10″ to ¼″ holes.

Riv'et-ing Knob. A cup-faced swage for closing down the rivet end upon the object or upon the bur, as the case may be.

Riv'et-ing Ma-chine'. Several forms of riveting machine are shown in Figs. 4349–4354, "*Mech. Dict.*," operating by pitman, cam, steam, hydraulic power, etc.

Fig. 2144.



Tweddell's Suspended Hydraulic Riveter.

Fig. 2144 shows the Tweddell portable hydraulic riveter and crane, for riveting locomotive-boiler foundation rings, wheel-tires, girders, crane-work, boilers, etc. The riveter is suspended from a specially designed hydraulic crane by means of which the riveter is made to command a considerable area without disconnecting a pipe-coupling or breaking a pipe-joint.

A slightly modified form of the same is shown more in detail in Fig. 2145.

It consists of two levers or arms abutting at one extremity, and carrying at the other two cupped dies, used to form the head of the rivet. Upon one of these levers rests the bottom of a hydraulic cylinder, in which works a plunger, carrying a crosshead furnished with tension bars, which, after passing through guides on each side of the cylinder, are fastened to the other lever, as shown in Fig. 2145. The fulcrum is not situated at the center of the length of the levers, but at a point distant about one third of that length from one end.

The riveter may be adjusted in its hangings to act on seams, oblique, horizontal, or vertical.

One man raises and lowers the riveter, adjusts it to the rivets, and then closes the dies on the rivets. Boys drop the red-hot rivets into place with the head of the rivet uppermost in horizontal work. With a skillful operator, as many as 6 to 10 red-hot rivets may be put in place ahead of him, and he can, on beam work, drive from 10 to 16 rivets per minute.

The machine is used with an accumulator which maintains an equable pressure adjustable from 250 to 2,000 pounds per square inch.

See also FIRE-HOLE RING RIVETER, Fig. 1036, p. 388, *supra*.

Small riveting machines are used for closing rivets on small articles of wear and convenience, such as brogans, boots, shawl-straps, valises, etc.

A hydraulic riveting machine driven by pump, and accumulator, is shown under ACCUMULATOR, Fig. 2, p. 2, *supra*.

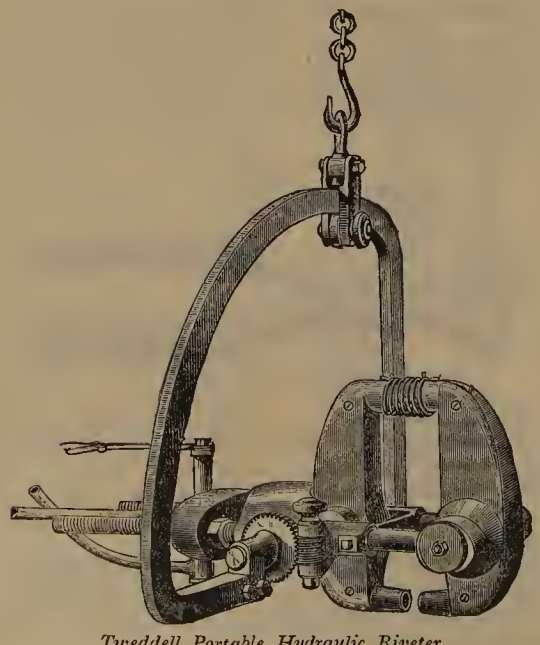
Adt . * "*Iron Age*," xxii., Oct. 24, p. 1.
Allen * "*Iron Age*," xviii., Oct. 5, p. 1; xxi., Apr. 18, p. 1.
Pneumatic, *Allen*.
* "*Engineer*," xlviii., 12; xlvi. 210.
Bement.
* "*Iron Age*," xxii., Oct. 3, p. 1.
Arrol, Br.
* "*Engineer*," xlvii. 32.
Maccoll, Br.
* "*Engineer*," xlv. 288.
McKay & McGeorge, Br.
* "*Engineer*," xlvii. 32.
Muir, Eng. . . . . * "*Scientific Amer. Sup.*," 2033.
Steam, *Pusey, Jones, & Co.* * "*Iron Age*," xvii., June 1, p. 1.
* "*Scientific Amer.*," xxxiv. 342.
Portable. *Sellers* . . . . * "*Scientific Amer.*," xli. 259.
Hydraulic, *Tweddell*, Br. . * "*Engineering*," xxi. 493; xxi. 115; xxvi. 61–64.
* "*Engineer*," xlvi. 230; xliv. 98.
* "*Railroad Gazette*," viii. 563.
* "*Man. & Builder*," xii. 105.
* "*Scientific Amer.*," xxxiv. 226; xlii. 146.
* "*Scientific Amer. Sup.*," 2225.
Plant (hydraulic) at Indret arsenal, *Tweddell*, Fr. . . . . * "*Engineering*," xxii. 3.
Suspended (hydraulic), *Tweddell*, Br. . . . . * "*Engineering*," xxvii. 66.
Rivet-heating furnace, Fr. . . . . * "*Scientific Amer. Sup.*," 1046.
Rivet-joints of steam boilers, *Cawley* . . . * "*Scientific Amer. Sup.*," 1527.
Rivet-making machine, *Collier*, Br. . . . . * "*Engineer*," xliv. 57.
* "*Scientific Am.*," xxxvii. 150.

Road Grad'er. See ROAD LEVELER.

Road Lev'el-er. A scraper for leveling heaps of dumped earth thrown up to form a road; and for rounding the earth towards the center of the road. It is a board, steel-shod, and traversing obliquely with the line of the direction of the road. Shown in *b*, Fig. 4693, p. 2058, and Fig. 4365, p. 1954, "*Mech. Dict.*"

Road crossing, standard * "*Railroad Gazette*," xxiii. 655.
Roadway of Kharran, Babylon to Egypt.
Builder . . . . . "*Van Nostr.'s Mag.*," xxiii. 290.
Road making . . . . * "*Scientific American*," xxxiv. 275.
Road plane, *Lafetree* . * "*Scientific American*," xl. 390.
Roads, Impt. of prairie.
Nicholl . . . . . * "*Scientific American Sup.*," 2399.

Fig. 2145.



Tweddell Portable Hydraulic Riveter.

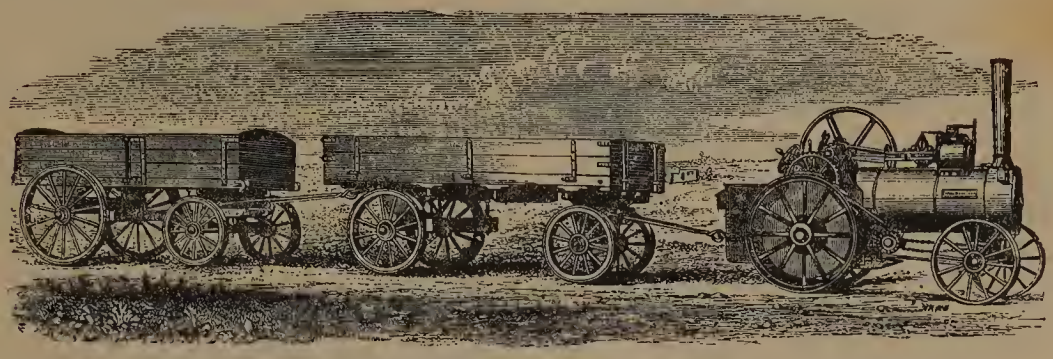
Road Lo'co-mo'tive. Notices of the early road locomotives, which preceded the railway locomotives, are given on pp. *1951, 1952, "*Mech. Dict.*" The modern forms of road steamers, made by Thomson and by Ransomes (Br.), are also shown in Figs. 4360, 4361, *Ibid.*

Fig. 2146 shows the Aveling & Porter road locomotive with two of the standard forms of wagons, made to carry 4 and 6 tons respectively. They are with iron or with wooden wheels and with sides and ends to let down or detach; in the latter case to make a platform truck.

See * "*Mech. Dict.*," pp. 1952, 1953.

History, machines and results . . . . . * Prof. Thurston's report, "*Vienna Exhibition Rep'ts*," 1873, iii., p. 33, *et seq.*
Road locomotive.
Marshall & Co., Engl. * "*Scientific American Sup.*," 886.
Trials, Wisconsin . . . "*Iron Age*," xxii., Aug. 1, p. 24.
Road steamer, Berlin . * "*Scientific American*," xliii. 406.

Fig. 2146.



Aveling & Porter's Road Locomotive.

Road roller, steam.
Aveling & Porter, Br. * "*Engineering*," xxvii. 564.
* "*Engineer*," xlviii. 30.
* "*Scientific Amer.*," xxxvii. 162.
Green, Br. . . . . * "*Engineer*," l. 245.
Lindelof . . . . . * "*Eng. & Mining Jour.*," xxi. 103.

Road Ma-chine'. A scraper mounted on wheels and used to excavate earth, transport it, and dump it *in situ*. Used in making road by excavating ditches at the side and throwing the earth into a rounded ridge to form the road. — *Pennock.*

See EXCAVATOR, p. 814; ROAD SCRAPER, pp. 1953, 1954; Fig. 4694, p. 2058, "*Mech. Dict.*"

Road Plow. A strong plow used for throwing up embankments, excavating ground to be moved by the scraper, etc.

Road Scra'per. 1. A horse shovel for moving earth. See Figs. 4366, 4367, p. 1954, and Figs. 4693–4695, p. 2058, "*Mech. Dict.*"

2. An implement with a long oblique blade which is drawn on the ground to level it, or to gently round it for a road bed. Fig. 4365, p. 1954, and *b*, Fig. 4693, p. 2058, "*Mech. Dict.*"

Roast'ing Fur'nace. A furnace for calcining ores to remove sulphur, phosphorus, arsenic, as the case may be. The forms and names are various: subliming, reverberating, shaft, cylinder, etc. See descriptions and illustrations on pp. 1954, 1955, "*Mech. Dict.*"

See list of Furnaces, p. 926, *Ibid.*

Brewster . . . . . "*Iron Age*," xxii., July 11, p. 20.
Brodie . . . . . "*Iron Age*," xxiii., Mar. 27, p. 15.
Calcining furnace ore.
Westman . . . . . * "*Iron Age*," xx., Aug. 23, p. 1.
Reverberating, Mining, Cal. . . . . * "*Engineering*," xxviii. 464.
Freiberg . . . . . *Painter's* report, "*Vienna Exposition Report*," iv. 40.
Revolving, *Manes* . . * "*Scientific American*," xxxiv. 79.
Rotary, *Bruckner* . . . * "*Eng. & Min. Jour.*," xxiv. 38.
Rotary cylinder.
Howell-White . . . * "*Min. & Sc. Press*," xxxvi. 209.
Shaft, *Gerstenhofer* . . *Painter's* report, "*Vienna Exposition Report*," iv. 35.
For silver ores, *Bruckner* * "*Engineering*," xxii. 575.
Process, *Holloway*, Br. . * "*Engineering*," xxviii. 38.

Rock Drill. These are of two kinds, working by blows and by rotation. The former have steel tools and the latter black diamonds.

See DIAMOND DRILL, Fig. 1631-1633, pp. 696, 697, "*Mech. Dict.*"; ARTESIAN WELL, *Ibid.*; ROCK DRILL, Figs. 4375-4380, pp. 1956-1958, *Ibid.*; ARTESIAN-WELL MACHINE, Fig. 114, p. 48, *supra.*

Rock breaker . . . . * "*Scientific American Sup.*," 605.
"New Blake" . . . * "*Iron Age*," xxiv., Nov. 20, p. 1.
American Diamond Rock Drill Co. . . . . . * "*Eng. & Min. Jour.*," xxiii. 150.
Barlow, Engl. . . . . * "*Scientific American*," xxxiv. 150.
* "*Scientific American Sup.*," 770.
Bartlett . . . . . *Laboulaye's* "*Dict.*," iv. "*Perforator.*"
Rock boring machinery, hydraulic, *Brandt*, Gr. "*VanNostrand's Mag.*" xvii. 567.
Brossman, Ger. . . . * "*Engineering*," xxx. 344.
"Kainotoman," *Dryden & Davidson*, Br. . . * "*Engineer*," xli. 209.
Bryer . . . . . * "*Scientific American Sup.*," 356.
* "*Scientific American*," xliii. 179.
* "*Eng. & Min. Jour.*, xxviii. 416.
Burleigh . . . . . * "*Scientific Amer. Sup.*," 753, 1713.
Cavé . . . . . *Laboulaye's* "*Dict.*," iv., "*Perforator.*"
Diamond . . . . . * "*Eng. & Min. Jour.*," xxii. 233.
"Union" . . . . . * "*Eng. & Min. Jour.*," xxii. 327.
Dubois & Francois, St. Gothard . . . . . * "*Engineering*," xxi. 44.
Cranston . . . . . * "*Engineering*," xxi. 85.
Fellot . . . . . *Laboulaye's* "*Dict.*," iv., "*Perforator.*"
Ferroux, Fr. . . . * "*Engineering*," xxi. 272.
"*Scientific American Sup.*," 311.
Frolich, Ger. . . . . * "*Engineering*," xxvi. 381.
Ingersoll . . . . . * "*Man. & Builder*," viii. 153; xi. 153.
Rock Crusher, *Gardner* "*Min. & Sc. Press*," xxxiv. 19.
Hand power, *Jordan*, Br. * "*Engineer*," xliv. 394.
"*Scientific American Sup.*," 1857; 1761.
Kainotoman . . . . * "*Scientific American Sup.*," 2253.
Knider, China . . . . * "*Engineer*," l. 230.
Leschot . . . . . *Laboulaye's* "*Dict.*," iv., "*Perforator.*"
Mershon . . . . . * "*Scientific American*," xxxvi. 358.
Penrice . . . . . *Laboulaye's* "*Dict.*," iv., "*Perforator.*"
Rand, "Little Giant" . * "*Scientific American*," xxxvii. 319.
* "*Scientific American*," xliii. 399.
* "*Eng. & Min. Jour.*," xxvi. 448.
Sach, Ger. . . . . * "*Engineering*," xxx. 434.
Shaw & Clark, Br. . . "*Scientific American Sup.*," 1538.
Rock borer (St. Gothard) * "*Scientific American Sup.*," 188, 374, 1392.
List of machines . . . "*Scientific American Sup.*," 2121.
Paper on, by *Darlington* Br. . . . . * "*Scientific American Sup.*," 1634.

Rock'er. (*Railway.*) A curved iron casting on which the body of a tip-car rests and rocks in discharging.

Rock'et. An illuminating or incendiary projectile.

The various kinds are cited and described on p. 1959, "*Mech. Dict.*"

Boxer's life-saving, rope-carrying rocket, for communicating with stranded vessels, is shown and described in "*Ordnance Report*," 1878, Appendix P, p. 314 and Plate XLI.

Illuminating . . . . "*Scientific American*," xxxviii. 72.

The rocket harpoon is one projected, in whole or in part, by the issuing at the rear of the gaseous results of the explosive.

See list of U. S. Patents, which also includes bomb harpoons and bomb lance, under HARPOON.

Rock'ing Bar. A bar in a stove or furnace on which the grate rocks, and in some cases tips.

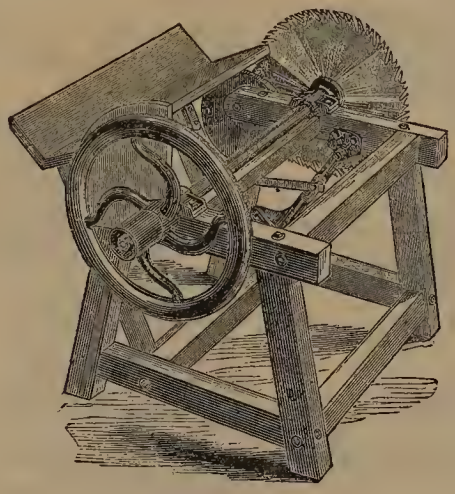
Rock'ing Pier. A bridge pier for supporting a railway track or iron truss across a ravine or

valley, its upper end having a motion longitudinally of the said truss as the same contracts or expands. It is a substitute for supporting the end of the truss upon rollers on a rigid pier.

It is used on the Dysdal Viaduct on the Christiana & Fredrikshald Railway, Norway.

The piers which support the superstructure are of wrought iron with lattice-work web. In the longitudinal direction of the viaduct, which is 603′ in length, there is only a single column between each span, possessing no stability in itself, and the upper end is allowed to move along with the superstructure when the latter expands and contracts. The lower end of each pier rests on a hinged shoe, so that breaking strains are avoided, and the load is always rendered central to the pier columns. The movement of iron work in a longitudinal direction is transferred to the one abutment on which are the necessary bed-plates, provided with rollers; on the other the superstructure is kept in place by a fixed shoe.

Fig. 2147.



Rocking Saw-table.

Rock'ing Saw'-ta-ble. A form of cross-cutting machine in which the stuff is laid on a table which rocks on an axis. The table is counterbalanced by a pendulous weight, and the thrusting forward of the table brings the stuff to the action of the saw, and conversely. Fig. 2147.

Rod Ma-chine'. A machine for making round sticks, such as dowels, pins, stretchers, broom-handles, etc.

The revolving head is on the principle of a hollow auger, and is mounted upon a column. A chuck of the proper size is fitted into the hollow arbor on which is the pulley driven by band from the countershaft beneath.

The feeding mechanism consists of two pairs of rollers; the receiving rollers are grooved to receive the square stick; the discharging rollers, circular grooved, to receive and feed out the finished rod. The rollers are geared and driven from one belt; are adjusted to the required pressure for feeding the stuff, and removable for different sizes. The receiving rollers are turned out of the way when changing the chucks or clearing them of broken rods. It will turn from 15′ to 25′ per minute. Three sizes are made: to work 1″ and under, 1½″ and under, 2″ and under, respectively.

Fay . . . . . * "*Engineer*," xlv. 435.

Rolled Plate Glass. Rolling glass has been to some extent substituted for casting on tables, in England, France, and Belgium.

"Instead of being cast with the costly apparatus necessary for plate glass of large sizes, this glass is cast in a very simple manner. A basin or dipper is introduced into the glass and filled up; this dipper is suspended upon a hook placed in front of the pot, to enable the workmen to dip and withdraw it with facility when it is full. This dipper is carried over an iron table, and by giving a blow upon it all the cooled filaments and pieces attached to the outside fall off. The dipper is now emptied over the casting table, the thickness of the glass being regulated by metallic pieces or rules. The roller is passed over the mass by the workmen, back and forth. These plates are sometimes impriuted with quadrangular ribs, very close to one another, in order to hide the defects or air bubbles which are likely to occur with this mode of dipping glass. These plates are usually cast about one eighth of an inch thick. They are used for covering hothouses, for door panels, and for windows." — *Colné.*

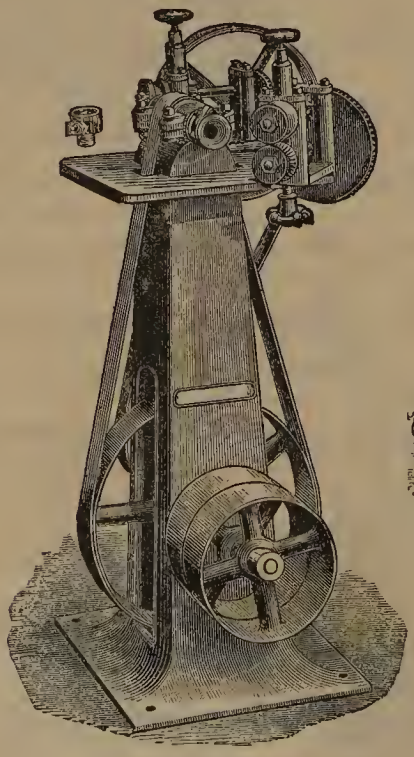
Rol'ler. 1. Land rollers and clod crushers are considered on pp. 572, 1962, 1963, "*Mech. Dict.*," and p. 201, *supra.*

Fig. 2149 is the roller adapted to steam plow culture.

The implement has a width of 15′, and may be fitted with any description of roller, smooth, corrugated, or sectional. The suspended frame is hinged in the middle and can be readily taken to pieces, so that in moving from field to field the two halves are pulled one behind the other, and pass conveniently along an ordinary or a farm road or through gateways.

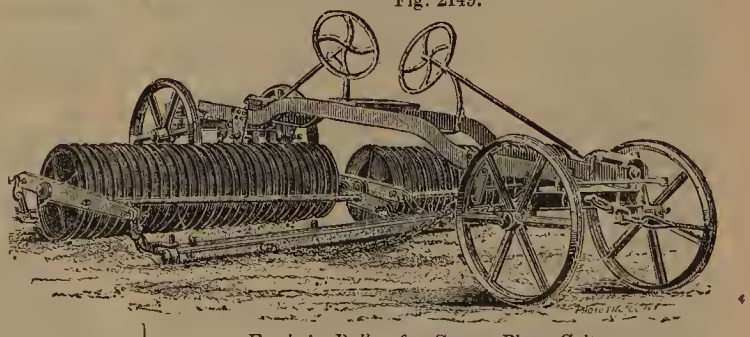
The French *Tombereau-rouleau* (cart-roller) has a cart body on a pair of iron rollers, for use on soft and treacherous soil. *Guilleux à Segre.*

Fig. 2148.



Rod Machine.

Fig. 2149.



Fowler's Roller for Steam Plow Culture.

The French roller, *Système-Hoolbrenk*, is scolloped and the ridges are sharp and penetrating.

2. Poole's calender rolls are shown in Fig. 499, p. 152, *supra.*

Manufacture of chilled . . . . . "*Scientific American Sup.*," 533.
Poole & Co. . . . . . * "*Scientific American Sup.*," 559.
French calendering machine, Fig. 500, p. 153, *supra.*

Rol'ler Bar. The sharp edge bar, or knife, in the bed of a rag-cutting machine.

Rol'ler Bear'ing. A socket for a roller journal, having anti-friction rollers on its interior perimeter. Fig. 263, p. 119, "*Mech. Dict.*" A *ring bush.*

Higley . . * "*Scientific American Supplement*," 1412.

Rol'ler Grip. The device for clutching the traveling rope in that system of traction of cars used on London and Blackwall railway in 1844. See ROPE RAILWAY, p. 1983, "*Mech. Dict.*"; INCLINED PLANE, *Ibid.*

The plan adopted in San Francisco and Chicago, and proposed for the East River Bridge, N. Y., consists in grasping the rope between sheaves or grooved steel rollers and applying brakes to the periphery of the rollers opposite the point where they come in contact with the rope. This permits perfect control of the movements of the car, as has been demonstrated on the Silver Street Railway in San Francisco, where there is a two-mile cable on a steep grade.

See WIRE ROPE RAILWAY, Fig. 7293, p. 2795, "*Mech. Dict.*"

Rol'ler Mill. 1. Specifically: a mill in which wheat is made into flour by a cracking process, by passing between rollers consecutively arranged in pairs.

The wheat passes through five sets of rollers, each set closer than the former. These rollers are 30″ long and 10″ in diameter. After passing between each set of rollers it is bolted. The last rollers have hardly anything but wheat hulls and the waxy germs which do not crack up, but smash together. The first rollers crack the kernels of wheat into say six pieces. The starchy substance which rattles out drops through the cloth sieves or bolting cloths.

These six pieces are broken between the next rollers into thirty-six pieces. Then the white starch crumbs are sifted out again, and the thirty-six pieces are passed between still tighter rollers, which crack them into 216 pieces; another set of rollers multiply each of these particles into six more, making them aggregate 1,296. Another set of rollers screwed together with tremendous pressure makes 7,776 pieces.

The numbers of course are only approximate, and are given merely to make the description of the process more clear.

See also CYLINDER MILL; HIGH MILLING, *supra;* ROLLER MILL, Fig. 4404, p. 1964, "*Mech. Dict.*"

See the following refereuces: —

On	* "*Am. Miller*," iv. 7, 23, 49, 61, 84.
Allis & Co.	* "*American Miller*," v. 169.
Granite roll, *Brinjes & Goodwin*, Br. . . .	* "*Engineer*," xlvii. 4.
Bucholz	* "*Engineer*," l. 90.
Buda-Pesth	"*Scientific American Sup.*," 1891, 2179.
Carter, Br.	* "*Engineer*," xlvi. 403.
Controversy and suits. .	"*Scientific American*," xlii. 265.
Daverio, Switz. . . .	* "*Engineering*," xxx. 250.
	* "*Engineer*," xlvi. 258.
Downton, middlings .	* "*American Miller*," iv. 48.
Escher, Wyss & Co. . .	* "*Scientific American Sup.*," 617.
Frauenfeld, Pesth . .	* "*American Miller*," viii. 40.
Ganz & Co., Buda-Pesth	* "*Engineering*," xxviii. 29.
	* "*Scientific American Sup.*," 2634.
Gray	* "*North Western Miller*," viii. 169.
Mechwart, Austria . .	* "*Engineer*," xlvi. 105.
	"*Engineer*," l. 90.
Namur	* "*Scientific American Sup.*," 617.
Stevens	* "*American Miller*," viii. 324.
Wegmann	* "*American Miller*," v. 101, 105.
Austria	* "*Engineer*," xlviii. 61, 64.
Switz.	* "*Engineer*," xlvi. 258.

2. Generally: the term includes various forms of mills for coarse grinding of grain for feed. See GRINDING MILL, *supra*, and references *passim.*

See list under MILL, p. 604, *supra.*

See also CANE MILLS; OIL CAKE BREAKERS; CALENDERING MACHINES, etc., and ROLLING MILL.

Rol'ler Skates. A long series of illustrated articles on this subject may be found in "*Engineer*," vol. xli., pp. 85, 102, 121, 129, 159, 167, 185, 208, 223, 241, 263, 287.

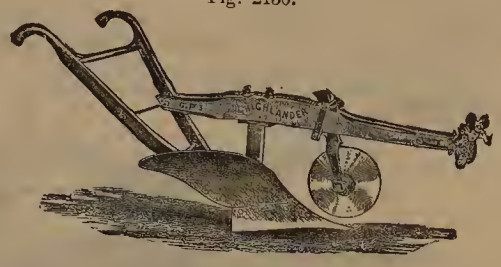
Roller skate, *Plimpton* .	* "*Engineer*," xli. 121.
Saladee	* "*Iron Age*," xix., May 17, p. 1.
Roller skate rink, N. Y.	"*Scientific American*," xl. 112.
Paris	* "*Scientific American Sup.*," 943.

Rol'ling Bridge. One whose roadway traverses longitudinally on piers as in the proposed Thames bridge. "*Engineering*," * xxi. 188, or on rails, as in Figs. 4407, 4408, p. 1985, "*Mech. Dict.*"

* "*Scientific American Sup.*" 312

Rol'ling Col'ter Plow. One having a circular sharp-edged disk rolling in advance of the mold-board to cut the sod.

Fig. 2150.



Rolling Colter Plow.

Rol'ling Mill. History, varieties, and patterns of rolled plates and bars, * pp. 1966–1969, "*Mech. Dict.*"

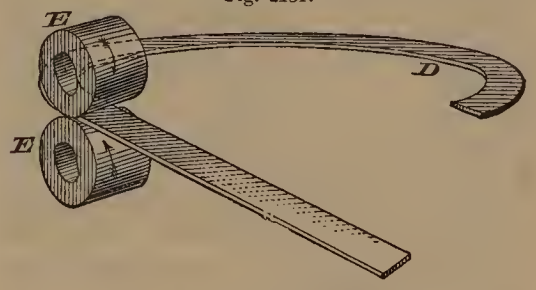
See also ARMOR PLATE, *Ibid. et supra.*

A rolled turret armor plate 13′ 10″ long, 8′ 6″ wide, and 2′ 7″ thick, weighing 65 metric tons, was shown at the Paris Exposition, 1878.

The rolling mill for sole-leather has a small brass roller, driven by steam-power and passing over a concave bed covered with brass, to which any degree of proximity may be given by a system of compound levers, thus giving any desired pressure. It is used for rolling sole-leather.

Japlin's process for making flat rings for lamp-shade and similar purposes consists in passing a strip between tapering

Fig. 2151.



Rolling Mill for Flat Rings.

rolls which expand the exterior perimeter more than the interior, giving a play to the strip which results in a flat ring. This is subjected to pressure in dies to give it any required form.

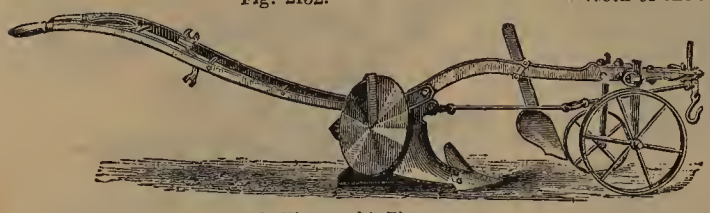
Rolling mill, first in Am.	"*Scientific American*," xlii. 291.
Mill and Engine, Bethlehem, Pa.	* "*Engineering*," xxiv. 320.
Rolling mill, Borisoglebsk, Russia . . .	* "*Engineering*," xxix. 6.
Carnegie Bros.	* "*Scientific American*," xlii. 143.
Phœnix Iron Co. . .	* "*Engineering*," xxix. 163.
Clutch, *Weston*, Br. .	* "*Engineer*," xlviii. 159.
Continuous, *Jenkins*. .	* "*Iron Age*," xxiii., March 20, p. 1.
Eye bars, *Kloman* . .	* "*Iron Age*," xxiii., April 24, p. 1.
Continuous, *Lauth* . .	"*Iron Age*," xxiii., March 27, p. 20.
Eye-bars, *Kloman* . .	* "*Iron Age*," xxxiii., April 24, p. 1.
Engine, *Brotherhood*, Br.	* "*Engineering*," xxi. 341.
Crewe, Br.	* "*Engineering*," 359.
Plate-rolling	* "*Iron Age*," xxv., Jan. 22, p. 1.
Reversing engine, Br. .	* "*Engineering*," xxv. 388, 430.
Reversing apparatus. *Christie*, Br.	"*Iron Age*," xix., May 10, p. 15.
Reversing gear, *Christie*	* "*Engineer*," xlii. 60.
Reversing-engines, Cleveland, Engl.	* "*Iron Age*," xix., Feb. 15, p. 1.
Reversing eugine. Eston, Br.	* "*Engineer*," xliii. 41.

Reversing, Farnley, Br. * "*Engineering*," xxii. 377.
Engines, Farnley, Br. . * "*Engineering*," xxii. 381.
Reversing, *Kloman* . . * "*Engineering*," xxvii. 19.
Reversing engine.
Kolpina, Russia . . * "*Engineering*," xxiii. 108.
Three-high for steel ingots
Billings . . . . . * "*Scientific American Sup.*," 396.
Wire-rod train.
Cambria Iron Co.. . * "*Engineering*," xxvi. 41.

Report by *Holley*, Group I., "*Centennial Reports*," vol. iii., p. 42.
Tunner on "Roll Turning."

Rol'ling-mold Plow. A plow in which a curved-faced roller is substituted for the rear portion of the mold-board. It is designed to lessen friction in turning over the furrow-slice.

Fig. 2152.



Rolling-mold Plow.

Ron'geur. (*Surgical.*) A bone-gnawing or gouging forceps. *Post's* rongeur is specifically for the mastoid bone.

Roof. References to structure, Figs. 4420–4423, and Plates III., LII., "*Mech. Dict.*"

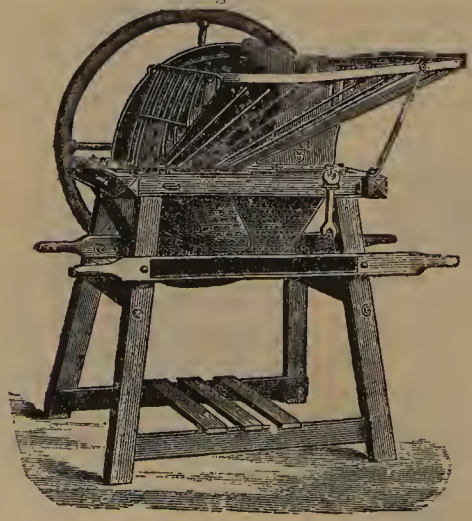
Particulars of recent improvements: —
Bituminous . . . . . "*Manufact. & Builder*," viii. 10.
Corrugated metal.
Brenton, Br. . . . . * "*Engineer*," xlvi. 21.
Iron . . . . . * "*Iron Age*," xix., May 10, p. 7.
For iron structures, zinc, lead, felt, glass . . . * "*Iron Age*," xx., Aug. 30, p. 5.
Lining, mineral wool . * "*Manufact. & Builder*," x. 108.
Materials, on . . . . "*Iron Age*," xxiii., April 3, p. 7.
(Northern Ry. of France) * "*Scientific American Sup.*," 663.
(Liverpool St. Station, London) . . . . . * "*Scientific American Sup.*," 663.
Railway Station, Engl. * "*Scientific American Sup.*," 920.
Sheet-iron, *Hyndman* . * "*Eng. & Min. J.*," May 3, xxvii.
Northrup . . . . . * "*Manufact. & Builder*," xii. 222.
Wide span . . . . . "*Scientific American Sup.*," 745.
Wooden, *Brown* . . . "*Scientific Amer.*," xxxix. 358.

Roofs and roof-trusses: * *Laboulaye's* "*Dict. des Arts et Manufactures*," vol. iv., ed. 1877, article "*Charpente*," Figs. 3389–3405.

"*Paving and roofing compositions*" is the subject of a volume containing a digest of the United States and British patents, by L. W. Sinsabaugh, Washington, 1875, and a subsequent supplement.

Campin. "*On the Construction of Iron Roofs, a Theoretical and Practical Treatise.*"

Fig. 2153.



Hornsby's Root Cutter.

Root Cut'ter. A machine for slicing roots for feeding to live stock.

There are various types: conical, cylinder, and disk, plain, toothed, shredding cutters, stepped cutters, double sets of cutters.

Several forms are shown in Figs. 4430–4432, pp. 1975, 1976, "*Mech. Dict.*"

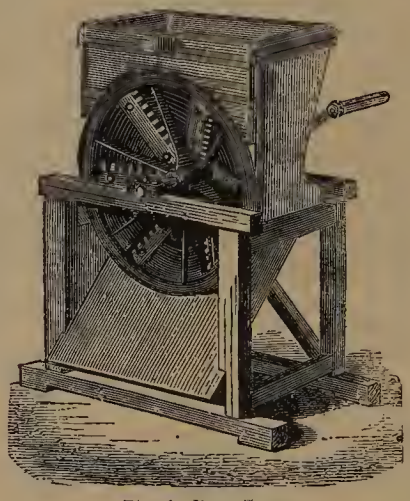
Fig. 2153 is the Hornsby root cutter (British). It cuts the root into finger pieces the whole length of the root. By the disposition of the hopper and curve of the knives the roots are not rolled in the hopper, but drawn toward the center of the disk, the result being that the finger pieces are delivered unbroken.

Fig. 2154 is Pinet's conical disk root cutter (French). The teeth of the knives project beyond the periphery of the cone and remove slices equal to the width of the teeth and of a thickness equal to the distance of their projection beyond the face of the cone. The weight of the roots in the hopper keeps them against the cone. The slices escape into the hollow cone.

Variations in the knives for the purposes of feeding cattle, sheep, etc., are found in several machines, otherwise similar in all features. Such machines are said to rasp, pulp, shred, mince, cut (*émincer*, *râper*, *couper*, etc.), as the case may be.

See * BEET-RASPING MACHINE, Figs. 262-264, *supra*.
Decauville (Fr.), * for beets in alcohol factory.

Fig. 2154.



Pinet's Root Cutter.

Laboulaye's "*Dict. des Arts et Manufactures*," vol. iv., ed. 1877, article "*Distillation.*"
See also *Ibid.*, iii. "*Sucre.*"
Stammer, French * Dept. Agriculture, Special Report No. 28, Washington, Plate XXII.
See also Knight's report on Group 76, Paris Exposition, "*U. S. Commissioner's Reports*," vol. v., pp. 206–212, embracing those of —

Bodin	France.
Hunt & Tawell	England.
Peckley, Sims, & Co..	England.
Malden Iron Works	England.
Pinet	France.

Root Dig'ger. A machine for lifting roots from the ground. Specifically for beets and potatoes.

Dr. Knight's report of Class 76 at the Paris Exposition of 1878 contains views and descriptions of the following implements ("*Paris Exposition* (1878) *Reports*," vol. v., pp. 49-52):

Potato-digger (simple effet)	France.
Potato-digger (double effet)	France.
Potato-digger, *Penney*	England.
Potato-digger, *Spear*	United States.
Beet-pullers, *Delahaie-Tailleur*	France.

Root-digger, Beet, *Eveloy*, "*French Dept. Agric. Sp. Rept.*," No. 28, Plates VII., VIII.
Delahaie-Tailleur, "*French Dept. Agric. Sp. Rept.*," No. 28, Plates VII., VIII.
Wahlkoff, "*German Dept. Agric. Sp. Rept.*," No. 28, Plate VIII.
See BEET ROOT DIGGER, Figs. 265-267, *supra*; POTATO DIGGER, *supra*.

Root Ex-tract'or. (*Dental.*) A fine pronged forceps. A gouge or claw.

Root Fil'ler. (*Dental.*) A tool for plugging cavities of carious teeth. See PLUGGER, *supra.*

Root For'ceps. (*Dental.*) An extracting forceps with narrow jaws. See list under FORCEPS, p. 354, *supra.*

Root Ma-chine'. See under the various heads, ROOT CUTTERS, ROOT WASHERS, etc.; also BEET RASP; BEET ROOT DIGGER; POTATO DIGGER, etc.

Dr. Knight's report on Agricultural Implements (Class 76), at the Paris Exposition of 1868, gives views and descriptions of the following machines for treating roots for food: —

Root-washer, *Bodin*	France.
Root-washer, *Pernollet*	France.
Potato-assorter, *Penney & Co.*	England.
Root-cutter, *E. Bodin*	France.
Root-cutter, *Hunt & Tawell*	England.
Root-cutter, toothed knife	England.
Double-acting root-cutter, *Picksley, Sims & Co.*	England.
Root-shredder, *Maldon Iron Works*, Maldou	England.
Root-cutter, *Pinel*	France.
Root-cutter, frusto-conical cutter	France.
Portable cooking apparatus, *Beaume*	France.
Agricultural caldron, *Fouché*	France.
Agricultural boiler, *Bodin*	France.
Steam-cooking apparatus, *Richmond & Chandler*	England.

Root Pul'ler. 1. A machine for lifting roots from the ground. See ROOT DIGGER, *supra.*

Fig. 2155.

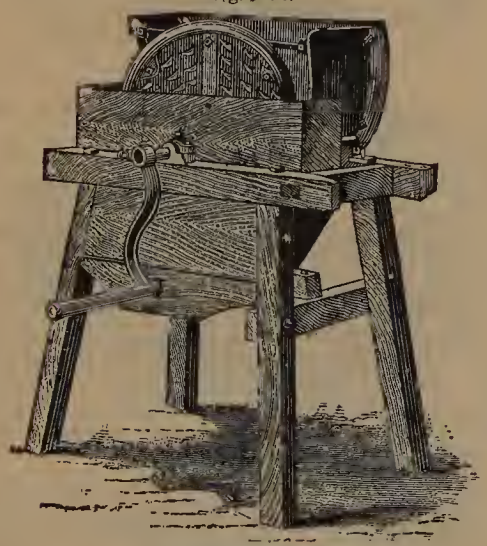
Root Puller.

2. A claw to which horses or oxen are hitched to drag roots from the soil in clearing land.

Root Rasp. A machine for pulping roots. See BEET ROOT RASP, Figs. 262–264, pp. 89, 90, *supra.*

Root Shred'der. A machine for reducing roots to shreds for feeding to stock. The machine shown in Fig. 2156 has a disk occupied by a multitude of tearing points in the sectors between the radial knives. The points tear the cut surfaces of the roots, and then the knife removes the ragged surface.

Fig. 2156.



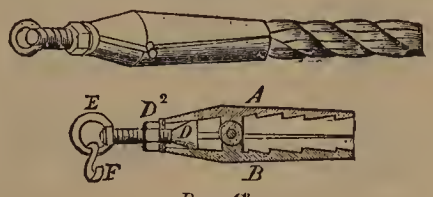
Root Shredder.

Albaret's root-cutter (Fr.), for slicing the beets used in the manufacture of sugar and alcohol, has six notched knives on a disk, and the slices of root pass into the case, and so to the floor below.

Rope Clamp. A device to secure the end of a cord, as in the case of a round lathe belt; or a connector for the signal rope of railway cars.

The clamping jaws, as shown in the engravings, are formed by two semi-tubes, *A* and *B*, made with teeth on their inner faces to hold the rope and prevent its slipping out. A pin passes through lugs on each to form a hinge

Fig. 2157.



Rope Clamp.

joint. This pin may be removed to attach the end of the rope by placing it on one jaw, when the other is laid upon it and the pin inserted. An inclined groove is cut in the solid ends of the clamping jaws, above the hinge, to receive a wedge, *D*, which is formed on the edge of the spirally threaded stem, on which is a nut, resting against a washer. *E* is a swivel ring on the end of the stem *D*, and *F* a hook on the ring for an attachment. The wedge is tightened by turning the nut D^2.

Rope-dri'ving Gear. A means of transmission of power from a driver to machinery. A substitute for belting.

In a notable case, in Manchester, England, the fly-wheel is made to serve as driving drum also; it is 22′ in diameter, and weighs about 20 tons. It is grooved for the reception of 12 hempen ropes, each 6″ in girth, six of the ropes being intended to drive one line of shafting, and six the other. The rope drums or pulleys on the shafting are 5′ in diameter: the rims are made heavy and are grooved, as is the driving drum, but for only six ropes. The width of the grooves is 2 7-16″; total depth, 3½″; the radius of the bottom curve, ½″; and the inclination of the two sides to each other is about 49°. It will be apparent from these particulars that the ropes do not, even when pressed somewhat out of shape when doing full duty, rest upon the bottom of the grooves, but on the sides, and the wear is, therefore, at the points of contact. The wear, after 18 months' use, was tolerably uniform all around the section, thus indicating that the ropes do not present the same parts of their circumference to be continuously gripped in the grooves.

See also CABLE CARRIER, Fig. 494, p. 150, *supra.*
WIRE WAY, Figs. 7306, 7307, pp. 2798, 2799, "*Mech. Dict.*"
WIRE ROPE, Fig. 7291, p. 2795, *Ibid.*

Gear	"*Scientific American*," xxxvi. 42.
Rope clamp, Page	* "*Scientific American*," xxxv. 99.
Rope driving gear.	
Goodfellow	* "*Scientific American Sup.*," 1268.
Smith, Br.	* "*Engineer*," xliii. 444.
	"*Iron Age*," xxi., April 25, p. 7.
Ropes, power transmission by	* "*Iron Age*," xvii., Feb. 24, p. 1.
Rope transmission in mills, *Pearson*	* "*Engineering*," xxi. 76.

Rope-mold'ing Ma-chine'. A machine for scroll-turning stuff for balusters, stretchers, etc.

The molding is cut by a revolving cutter head, with cutters to suit the style or size of work. The stick being first turned round by a rod, machine or lathe, is fed in, and at the same time revolved by the feed attachment, the feed and guides being adjustable to the different sizes. The machine works any size, from ⅜″ down, making a very smooth finished molding, requiring little or no after finish. By an arrangement for working the stick at an angle with the cutters, the style of the twist can be altered, and made close or open, as desired. — *Rogers.*

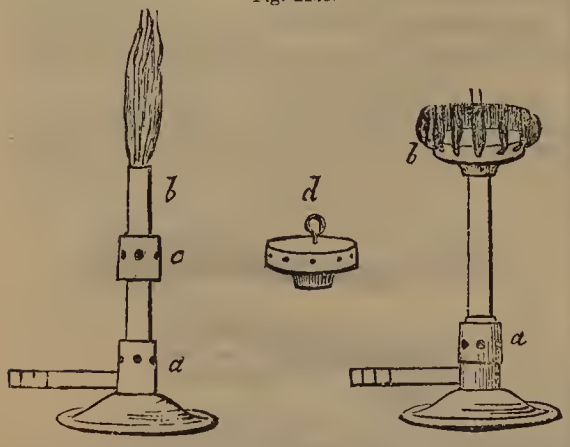
See also BALUSTER LATHE, p. 71, *supra.*
CARVING ATTACHMENT FOR LATHES, Fig. 555, p. 174, *supra.*

Rose Burn'er. Or *Rosette Burner.* A form of gas burner in which the gas issues at a circular series of openings, the jets resembling petals. See BUNSEN-BURNER FURNACE.

See also *b c*, Fig. 5924, p. 2411, "*Mech. Dict.*"
The burner shown in Fig. 2158 gives a single flame for

crucibles, and a circle of flames when liquids are to be heated in vessels of glass or porcelain. The burner *a b* is similar to

Fig. 2158.



Rose Gas Burners.

Bunsen's; *c*, a regulator to control the entrance of the air into a box, *a*, and thus prevent the flame from blowing down; *d*, the rose, which divides and spreads the flame when put on the top of tube *b*. *e* shows the single or igniting flame; *b*, the spread or evaporating flame.

Rose Glass. A celebrated French glass, prepared in a special manner.

A certain quantity of auriferous glass is prepared beforehand, and run in thin plates, and fragments of these plates are used by the glass blower to fuse upon his work, and thus give it a superficial coloration. It often happens that the same composition of auriferous crystal gives plates of very different shades, some colorless, others tinged more or less deeply with rose or red, and some almost black; these differences being due to two causes, namely, the temperature of the furnace in which the fusion has been effected, and the temperature of the mold into which the melted metal is run. For light colored plates the temperature of the furnace is made low, and the mold very cold; blue plates are sometimes produced under the same circumstances, which, if reheated, take the normal color, as do also the colorless and very pale rose glasses. Crystal colored with gold is merely a vitreous matter, holding in suspension metallic gold in a state of very fine subdivision. It is stated that on attentively examining the red plates, it is easy to recognize in the mass a multitude of most brilliant specks of metallic gold, forming a sort of aventurine (which see).

Ro-sette'. (*Nautical.*) A form of knot. See 32, Fig. 2777, p. 1240, "*Mech. Dict.*"

Ro-sette' Cut'ter. A steel cutter of inverse form for forming a circular ornament of wood.

Fig. 2159.

Boult's Rosette Cutter.

Ros'in Core. A dry-sand core in which rosin has been used for the purpose of increasing the adhesiveness and strength of the sand when dried.

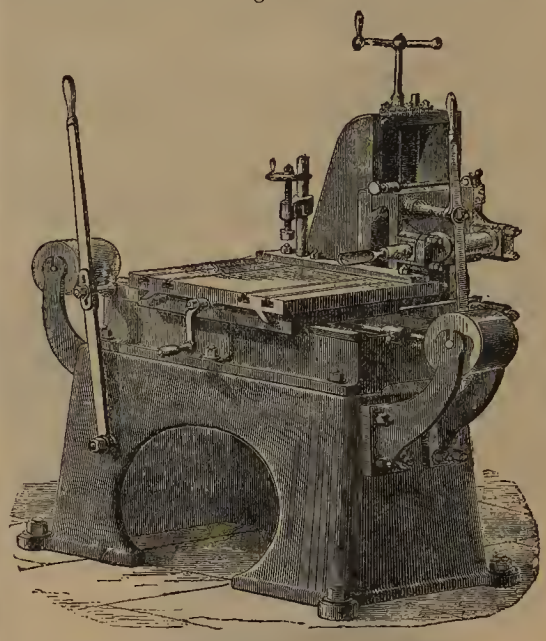
Ros'in Oil. (*Leather.*) A compound of melted rosin and linseed oil.

Ro'ta-ry-bed Pla'ning Ma-chine'. One with a continuously moving bed. See TRAVERSING-BED PLANING MACHINE, Fig. 6627, p. 2620, "*Mech. Dict.*"

Ro'ta-ry En'gine. See ROTARY STEAM ENGINE.

Ro'ta-ry Mor'tis-ing Ma-chine'. A form of mortising machine in which the cutter revolves and works by a routing action; as distinct from the ordinary form, in which the cutting is done by a reciprocated chisel.

Fig. 2160.



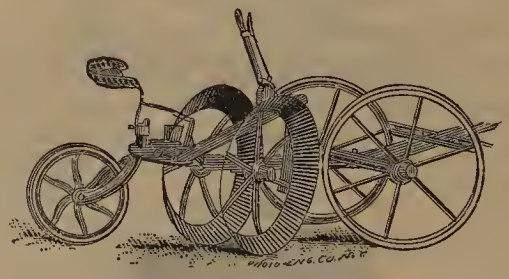
Mortising, Routing, and Recessing Machine.

The work is dogged or chucked to a table which has a compound movement and subjected to the action of a rotary router.

Ro'ta-ry Plow. A rotary plow which acts as a spader is shown in Fig. 4464, p. 1988, "*Mech. Dict.*". See also SPADING MACHINE, p. 3252, *Ibid.*

The rotary plow shown in Fig. 2161. The piece acting as share and mold-board is a circular disk or conical frustum

Fig. 2161.



Rotary Plow.

which penetrates the soil, lifts a slice and turns it over. The cut shows a double or two-furrow plow.

Ro'ta-ry Pump. A pump which acts by a rotary, in contradistinction to a reciprocating action.

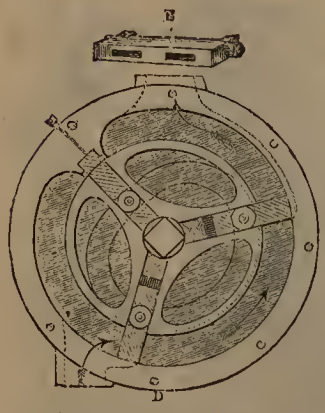
Under the caption ROTARY PUMP, pp. 1988, 1989, "*Mech. Dict.*," 24 illustrations are given of rotary pumps of various kinds: single and double pistons and centrifugal.

In the illustration of the Douglas pump, Fig. 2162, the shaded portion with arrows indicates the water and its direction. The pistons are three in number, and operated by a scroll race in which the rollers of the pistons work. By this means the pistons are held against the inner perimeter of the cylinder in which they work, and withdrawn to pass the abutment. Passages through the slides balance the water pressure on their respective sides.

Samain's pump (French) is shown in Fig. 2163. It has four palettes, arranged in pairs and moving in slots in the cross of the arbor. They are so arranged that when one is out, abutting against the interior perimeter of the chamber, the other is in, passing its lowest position in contact with

the abutment. The arrows show the direction of the water.

Fig. 2162.

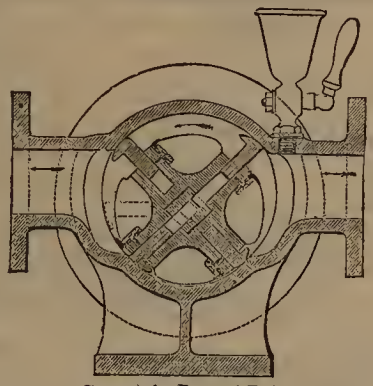


Douglas Rotary Pump.

Fig. 2164 is the Bagley and Sewall rotary pump in which an eccentric ring rotates in the cylinder. It is shown by vertical section.

A is the main case or body of the pump in one piece, on the interior of which is the ring *B*; the space outside of *B* being the cylinder or water space. This cylinder is inclosed by a disk which is attached firmly to the shaft. To the disk is attached eccentrically a ring *E*, a portion of which is always in contact with the outside of casing *A*, and also with the ring *B*, at a point exactly opposite; so that the eccentric ring *E* is really the piston of the pump; the disk and ring being rotated by the shaft driven by pulleys. *I* is the suction port, and *J* the discharge. These ports are separated by the sliding abutment *H*, which moves back and forth on its seat with the throw of the eccentric ring *E*. The tumblers fitted to this abutment adjust themselves to the ring, and as the pressure is constant upon them from above, they effectually pack the ring and prevent any escape of water below.

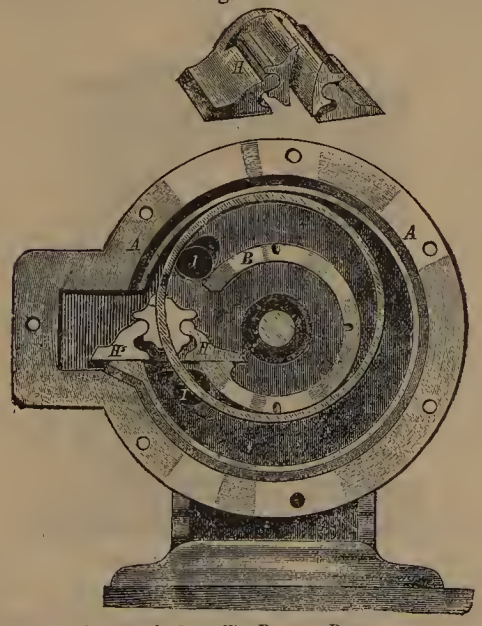
Fig. 2163.



Samain's Pump (Fr.).

The water enters at *I*, and as the piston ring rotates, it is forced before and between it and the casing, around to the upper portion of the latter and out at the port *J*. As the ring rotates it opens a space between its inner periphery and the fixed ring *B*, into which space the water from port *I* enters, filling the interior of the piston, to be forced out as before. The outer ring *B* is made enough deeper than the casing *A*, to exactly equalize the contents of the inside and outside of the piston ring *E*, thus securing a perfectly steady flow of water from the discharge. *F* is the cover or outside case. Holes are made through the disk *D* to allow the water to pass through and between it and the outer case, thereby balancing the working parts, and equalizing the pressure upon them. One end of the shaft has a closed bearing in this outer case; the other bearing is in the case *A*. On the shaft, and being a part of the disk *D*, is a collar which is fitted to the seat *K*, making a perfect water-tight joint, by which all "packing" of the pump is avoided. In the center of the seat *K* is a circular groove, which connects by a drilled channel with the suction port. Should there be any tendency to escape of water at the seat *K*, the force of the suction keeps the port closely to the seat, and absolutely sealed against air or water.

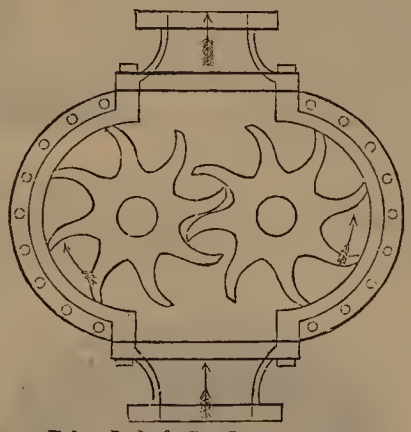
Fig. 2164.



Bagley & Sewall's Rotary Pump.

Fig. 2165 is the double wheel pump of Fales, Jenks & Co. The arrows show the direction of the water, and thus indicate the direction of rotation of the disks or wheels, the contact of the arms of which as they mutually rotate inwardly and downwards is the substitute for the abutment in the single disk machine.

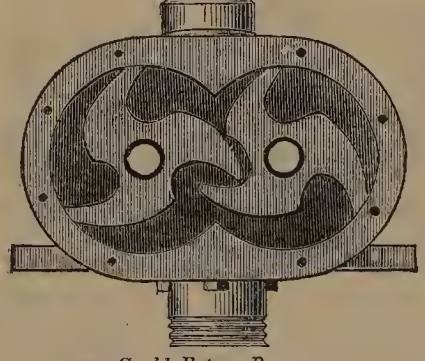
Fig. 2165.



Fales, Jenks & Co., Rotary Pump.

The Gould rotary pump, Fig. 2166, has a pair of pistons acting in concert, as in the last-mentioned case, but the arms are but three on each disk, and the contact is made by the projection of the arm of one into a circular depression in the other mutually and alternately.

Fig. 2166.



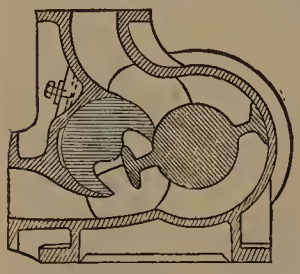
Gould Rotary Pump.

The Greindl pump, Fig. 2167, consists of two disks revolving at different velocities within a casing. One disk carries two fixed arms, which act as pistons. The other disk has a recess in it, which allows the arms to pass in revolving. Motion is communicated to one disk by means of a strap or patent three-cylinder steam engine, and the other disk is driven by spur gearing.

The Holly rotary pump is shown in Fig. 2168, which shows one side of the case removed, revealing its construction and working parts. These consist of a pair of corrugated cams working together within an elliptical case, the ends of the long teeth being packed by blocks of metal in-

serted into the grooves and pressed out by springs, thus insuring a perfect vacuum and the taking up of any little wear there may be after years of pumping.

Fig. 2167.



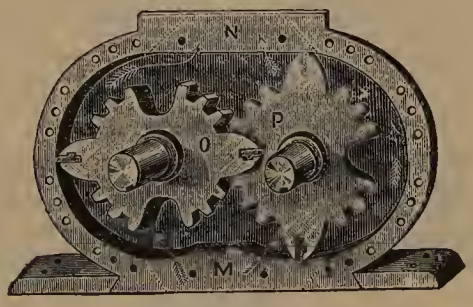
Greindl's Rotary Pump.

The water enters at the bottom through the suction *M*, the stream dividing and filling the chambers made by the long teeth, passing around the cams *O* and *P*, and discharging from the top through the outlet *N*. The motion of the pump is equable, continuous, and rotary, the cams working together inwards from the top. Thus, when one chamber has just discharged, another is discharging, another one is on its way, and still another one is just filling, so that the stream is always uniform and steady.

The Silsby rotary pump is shown in Fig. 1031, p. 337, *supra*.

Lift pump, *Bamford & Sons*, Engl. . . . . * "*Scientific American*," xl. 51.
"Comet," *Bartrum & Powell*, Br. . . . . * "*Engineer*," xlvi. 143.
Crocker . . . . . * "*Scientific American Sup.*," 2374.
Doremus . . . . . * "*Scientific American Sup.*," 182.
* "*Scientific American Sup.*," 293.

Fig. 2168.



Holly Rotary Pump.

Greindl's Nijni-Novgorod, Rus. . . . . * "*Engineering*," xxx. 341.
Greindl . . . . . * "*Eng. & Min. Jour.*," xxiii. 103.
Hougoux . . . . . * "*Scientific American*," xxxvi. 182.
Rotary steam circulating engine and pump, *Manley*, Br. . . . . * "*Engineering*," xxv. 451.
Rotary pump, *Newcomb* * "*Scientific American*," xliii. 50.
Force pump, *Newcomb* . * "*Scientific American*," xxxviii. 358.
Ortman . . . . . * "*Scientific American*," xli. 6.

Ro'tary Sha'per. See SHAPER.

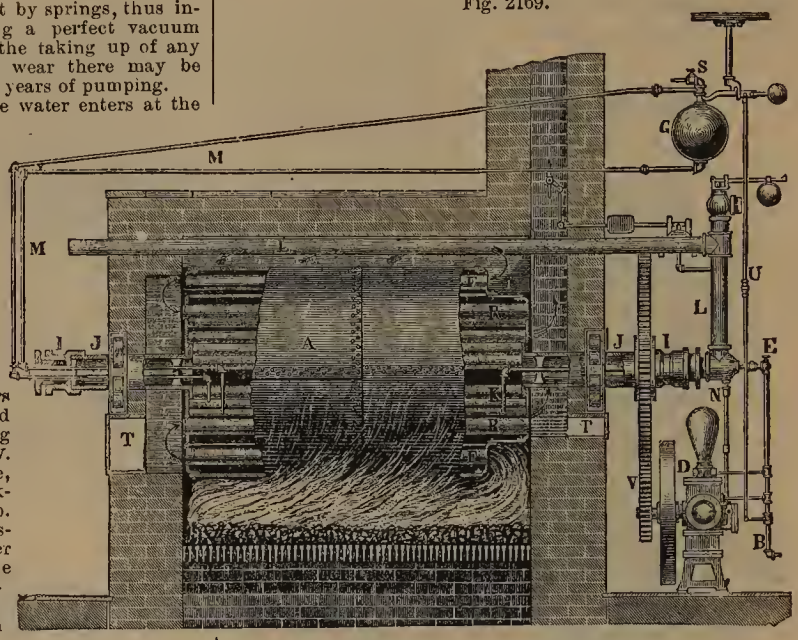
Ro'tary Steam En'gine. (*Steam.*) The name is applied not alone to the rotary piston engine, but also to those reciprocating engines — of which there are numerous examples in waterworks engines — which have a fly-wheel and crank shaft.

The class of steam engines ordinarily known as *rotary*, are exhibited in 28 illustrations, pp. 1690–1092, "*Mech. Dict.*"

See also the following references: —

Apperley . . . . . "*Scientific American Sup.*," 1617.
Behren . . . . . *Deschanel's* "*Natural Philosophy*," i. 481.
Coomber, Br. . . . . * "*Engineer*," xli. 42.
Coomber . . . . . * "*Scientific American Sup.*," 165.
De Groat . . . . . * "*Scientific American*," xlii. 310.
Dexter, Br. . . . . * "*Engineer*," l. 218.
Gallahue . . . . . "*Scientific American*," xxxv. 1.
Hajni . . . . . "*Engineering*," xxvi. 491.

Fig. 2169.



Pierce Rotary Tubular Boiler.

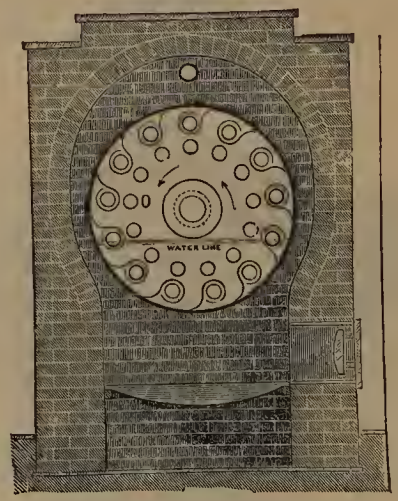
Henderson . . . . . * "*Scientific American*," xl. 326.
High-speed, *Hoason*, Br. * "*Engineer*," l. 417.
Lawrence . . . . . * "*Engineer*," xlviii. 163.
Lawrence . . . . . * "*Scientific American*," xl. 259.
Lidgerwood . . . . . * "*Scientific American*," xxxv. 182.
Noteman . . . . . * "*Amer. Man.*," Dec. 31, 1880, p. 9.
Noteman . . . . . * "*Scientific American*," xl. 406.
Silshy Man. Co. . . . * "*Thurston's Vienna Report*," ii. 105.
Stiles . . . . . * "*Min. & Sc. Press*," xxxvi. 401.
Titus . . . . . "*Scientific American Sup.*," 292.
Weigho (Ger.) . . . . "*Manufact. & Builder*," viii. 193.

Laboulaye's "*Dict. des Arts et Manuf.*," iv., ed. 1877, article "*Machines à vapeur*," shows the engines of —

Watt. *	*Behrens.* *	*Girard.*
Cochrane. (2) *	*Pecquerer.* *	
Thomson. *	*Hicks.* *	

Ro'ta-ry Tu'bu-lar Steam Boil'er. The Pierce rotary tubular boiler (Figs. 2169, 2170) is a cylindrical rotary tubular steam boiler, with two circular rows of tubes running from end to end. The outer rows of tubes are surrounded by buckets or elevators which are so arranged as to nearly encircle them, and to cover the inner surface of the

Fig. 2170.



Pierce Rotary Tubular Boiler.

boiler-shell with water at each revolution. The inner row of tubes act as superheaters for drying as

well as generating steam. The boiler is incased in brick-work and is supported upon trunnions at each end in such a manner that it is rotated by gearing actuated by the steam pump that supplies the boiler with water, or other motor power.

The boiler is at all times one-quarter full of water, which amount is unchangeable, being regulated by an automatic feed-water regulator.

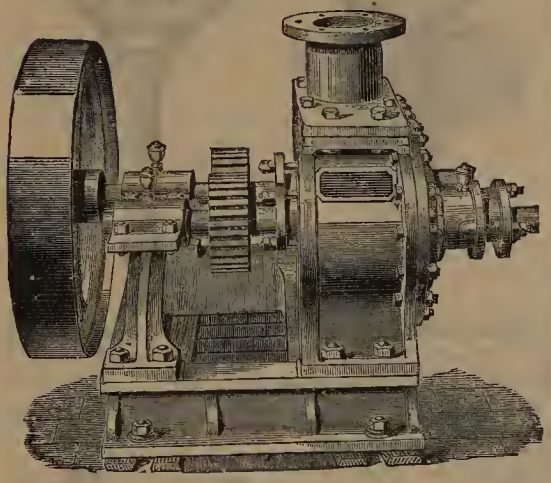
The feed-water is introduced through one trunnion, and the steam withdrawn through the opposite trunnion.

The grate has an area equal to the entire iuner hase of the brickwork surrounding the boiler.

The flame and heated gases arising from the grate completely surround the boiler, thence pass through the outer row of tubes to the opposite end, emerging into a chamber, thence returning through the inner or superheating row of tubes, en route to the stack or chimney.

Ro'ta-ry Wa'ter En'gine. Behren's rotary water engine (English) is a simple form of motor having but few moving parts. It consists of a casing bored out to receive two piston blocks, which furnish an alternate abutment to each other. The pistons are counected by spur wheels, and their motion is therefore perfectly uniform and continuous.

Fig. 2171.



Appleby Bros. Rotary Water Engine. Behren's Patent.

No power is lost in overcoming the inertia of reciprocating, and no fly-wheel is required. It is the rotary engine common in the domain of steam, but in this case driven by water pressure. The same set of pistons moved by mechanical connection from an exterior motor may constitute a rotary pump. See pp. 1991 and 1988, 1989 respectively, "*Mech. Dict.*"

Ro-ta'tor. An apparatus for producing iron by the direct process.

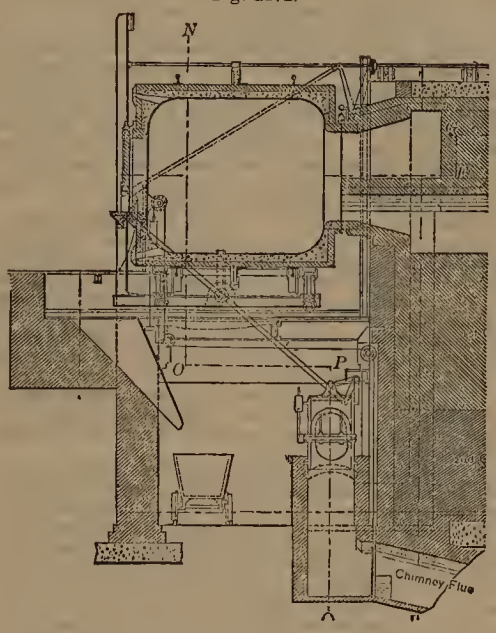
"The apparatus, or 'rotator,' Figs. 2172, 2173, consists of a revolving furnace, lined with oxide of iron. Gas from producers and air from one pair of regenerators enter at one end of the furnace, burn and reverberate within it, and pass out at the same end into the other regenerator. There is a large charging and discharging door at the other end of the furnace.

"At Dr. Siemens' Works, at Towcester, the small rotator, 9½′ long by 8½′ in diameter, takes a charge of 30 cwts. of ore mixed with 8 cwts. of small coal. In about 2½ hours the reduction of the ore is completed; the slag is tapped off, and the heat and speed of rotation are increased to form the mass into an elongated ball, which is hammered into a bloom. An average of 43 consecutive charges at Towcester gave the following results: —

Iron in ore charged, lbs.	1,274
Coal, lbs.	728
Time for operation	3.12
Blooms made, lbs.	1,113
Loss, per cent.	12.6
Coal in producers per ton of blooms, tons	2

"The particles of iron forming the blooms, if perfectly separated from the slag, are practically pure, however impure

Fig. 2172.

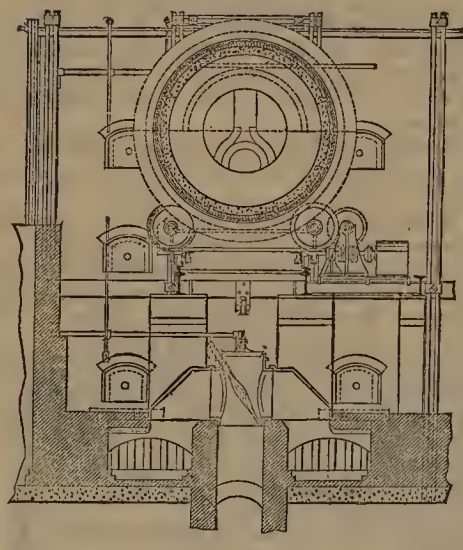


Siemens' Rotator.

the ore may be. The slag contains sometimes 6 per cent. of phosphoric acid and one to two per cent. of sulphur. The pure iron will alone remain in the open-hearth bath, although some few hundredths of phosphorus may be taken up from the slag at the highest temperature.

"The first trial of the process in the United States was at Park Bro. & Co.'s Works, in Pittsburg. There were no serious difficulties, except the oxidation referred to, in the manufacture of the balls into wrought iron. Within the last few months a large rotator, 11′ long by 11′ in diameter, has been started at Tyrone Forges, Pa., by Mr, Robert J. Anderson, of Pittsburg, to make material for his open-hearth furnaces. Although the operations have purposely been experimental, with various ores and lining materials, enough has been done to show that a product of excellent quality may be got from any ore, and that linings (necessarily oxide) may be adapted to any ore, although a very silicious ore requires the use of so much lime that the repairs of linings are proportionally increased.

Fig. 2173.



Siemens' Rotator.

"In an average week's work at Tyrone, with Robinson ore and the highly silicious Pennington ore, the mixture having about 50 per cent. of iron, the charges were: Ore, 4,000 lbs.; reducing coal, 600 to 700 lbs.; limestone, 250 lbs.: scale and cinder, 800 lbs. The yield of blooms was 1,600 to 1,700 lbs. per charge, or 80 to 85 per cent. of the iron in the ore. The producer coal was 3,800 lbs. per ton of blooms. The week's work was 19 operations, producing 14 tons of blooms.

"The cost of blooms, with ore averaging about $3 and coal $2.15, and with labor charged at the very high rate of $10 per ton, was a little over $25 per ton. Experimental labor is of course excessive, and in this case the men could have just as well run four furnaces as one. Labor should not exceed $2.50 to $3 per ton in a plant of four rotators. The output has been gradually increasing and has reached five operations per 24 hours. The producer coal has also been gradually decreased. Of course working costs can be only approximately determined from experimental costs, but it seems safe to say that blooms can be produced at a small advance over the cost of pig from the same ore.

"The cost of a plant of four rotators, ore crushers, hammer or squeezer, etc., exclusive of building, is about $40,000, and its output with existing appliances only, in regular rather than in experimental work, is estimated at 125 tons per week. This looks at first like a small output, but it must be remembered that the entire blast furnace plant is dispensed with. An obvious improvement, not in any way experimental, is about to be introduced. It is calcining the ores in any suitable kiln and running them red hot into the rotator. As about half the time of the operation is now occupied in getting the charge up to a reducing temperature, it is obvious that the calcining — a cheap operation — will nearly double the output of a rotator plant.

"Charcoal blooms are at present the best material in the market for making fine open-hearth steel; they are used together with the smallest possible bath of Bessemer pig for the finest fire-box plates. If Siemens direct blooms (even should they have more mechanical impurities) are not as good as charcoal blooms for open-hearth steel, the reason is not obvious. Such practice as there is seems to prove them equally good. As I have similarly stated in previous papers describing new processes, the object of these notes on the Siemens' process is not to compare it commercially with other preparatory processes, but simply to state its existing *status* and the probable course and means of its further development." — *Holley.*

Roth'er-nail. (*Shipwright.*) A large headed nail used for fastening the rudder-irons of ships.

Rough'ing Hor'ses. A simple mode of roughing horses, practiced in Russia, consists in punching a square hole in each heel of the shoe, which, in ordinary weather, may be kept closed by a piece of cork. When the ground is slippery, the cork is removed, and a steel spike inserted. If this steel rough be made to fit the hole exactly, it remains firm in its place, and is not liable to break off short at the neck like some of the screwed spikes.

Round Bar Spi'ral Spring. A spring of round steel coiled around a mandrel; as distinguished from a *flat-bar* coiled spring. See illustrations of each in Fig. 1143, p. 483, "*Mech. Dict.*"

Round'ing Ma-chine'. 1. A wood-working machine, also known as a cornering machine, used in chamfering off the corners of stuff; especially in implement and carriage work. See CHAMFERING MACHINE.

2. A machine for making round rods and spindles. See ROD MACHINE, PIN MACHINE, and DOWEL MACHINE.

3. A machine to round book backs. See BOOK-BACKING MACHINE, Fig. 381, p. 120, *supra.*

4. A machine for giving the rounded depressions in blanks for shoe soles. A sole-stamping machine.

Rough Point'ed Stone. (*Stone Cutting.*) When it is necessary to remove an inch or more from the face of a stone, it is done by the pick or heavy points until the projections vary from $\frac{1}{2}''$ to $1''$. The stone is then said to be rough pointed. This operation precedes all others in dressing limestone and granite.

See POINTED WORK.

Fig. 2174.

Round Iron.

Round Iron. The plumbers bulbous iron used in smoothing solder joints of lead pipe.

Round Scut'tle. (*Nautical.*) A scuttle with a circular frame suitable for iron ships, with brass door for glass, brass screw fastening, painted iron frame, and hinged iron dead-door complete.

Round Seiz'ing. (*Nautical.*) A loop made in rope by a single turn on itself, and seizing the crossing. See *c, e,* Fig. 4825, p. 2091, "*Mech. Dict.*"

Round Swage. (*Blacksmithing.*) A form for shaping iron.

Row'ing Gear. Outriggers and various devices to assist the oarsman. See OAR, Fig. 1824, p. 637, *supra.*

Lyman	* "*Engineer*," xliii. 340.
	* "*Iron Age*," xix., April 12, p. 5.
	* "*Scientific Amer.*," xxxiv. 343.
Rowing sled, *Dennis* .	* "*Scientific Amer.*," xlii. 387.
Rowlock, *Spelman* . .	* "*Scientific Amer.*," xxxvii. 70.

Davis rowing gear (Courtney's mysterious rig), Patents Nos. 231,016, 231,017.

Fig. 2175.

"*Acme*" *Rowlock.*

Row'locks. (*Boat*). Spaces in the gunwale for the oars to rest in rowing; or contrivances on the gunwale for the same purpose.

The Acme rowlock is used without a laniard; and, instead of removing the horns from the sockets when along side of vessels or wharves, as is required with most other rowlocks, simply turn them half way around, and they fall of their own gravity below the gunwale, obviating the necessity of removal from the sockets, except when it is desired to do so.

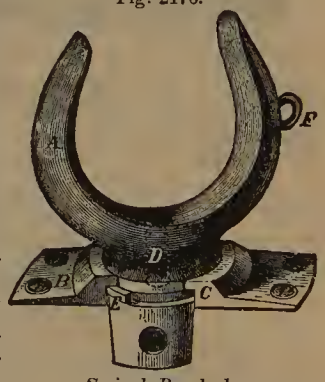
In Fig. 2176 the rowlock plate *B C* is firmly fastened on top of the gunwale, and does not weaken it like the cutaway swivel rowlock, with sockets.

Fig. 2177 shows an outrigger rowlock wood-lined.

The Navy rowlock, Fig. 2178, is instantly changed from its position to a hanging one, or can be detached from the boat. To detach, turn long horn aft, draw up, and turn out.

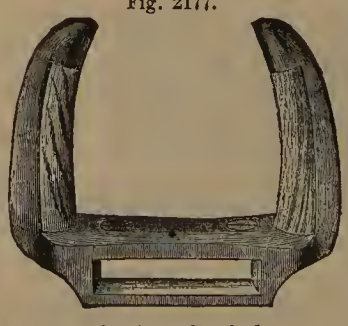
It is automatic in its motion, adapting itself to the motion of the oar, and always in position to receive it, *i. e.*, "fore and aft" the boat.

Fig. 2176.



Swivel Rowlocks.

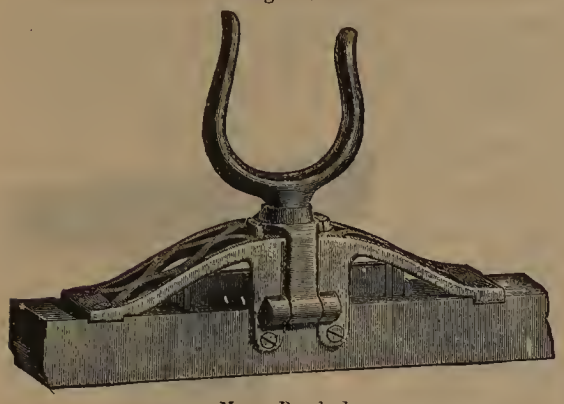
Fig. 2177.



Outrigger Rowlock.

Row Mark'er. (*Agric.*) An implement for marking out ground for planting in rows. See MARKER, Fig. 1681, p. 584, *supra.*

Fig. 2178.



Navy Rowlock.

Rubbed Stone. (*Stone-cutting.*) In dressing sandstone and marble, it is very common to give the stone a plane surface at once by the use of the stone saw. Any roughnesses left by the saw are removed by rubbing with grit or sandstone. Such stones, therefore, have no margins. They are frequently used in architecture for string courses, lintels, door jambs, etc., and they are also well adapted for use in facing the walls of lock chambers, and in other localities where a stone surface is liable to be rubbed by vessels or other moving bodies.

Rub'ber. Caoutchouc; a vegetable gummy substance obtained from a number of plants and trees, and entering as an element very extensively into mechanical productions.

The coast region north and south of the Congo is becoming quite an important source of caoutchouc. It is produced by a giant tree creeper (*landolphia*), which grows principally along the water-courses. It covers the highest trees, and frequently considerable extents of forest are festooned down to the ground, from tree to tree, in all directions with its thick stems, like great hawsers. Sometimes its stem is as thick as a man's thigh. Above, the trees are nearly hidden with its large, glossy leaves of dark green hue, and studded with beautiful bunches of pure white star-like flowers, most sweetly scented. Its fruit is of the size of a large orange, yellow when ripe, and perfectly round, with a hard, brittle shell; inside it is full of a soft reddish pulp of an agreeable acid flavor, much liked by the natives. It is not easy to obtain ripe seeds, as the creeper is a favorite resort of a villainous, semi-transparent, long-legged red ant — with a stinging bite, like the prick of a red-hot needle — which is very fond of the pulp and the seeds distributed through it.

Every part of the creeper yields a milky juice when wounded; but, unlike the juice of the American rubber tree this milky sap will not run into a vessel placed to receive it. It dries so quickly that a ridge is soon formed over a cut, and the flow arrested. When collecting it, the natives make long cuts in the bark with a knife, and as the sap gushes out they wipe it off continually with their fingers and smear it on their arms, shoulders, and breasts, until a thick covering is formed. Then they peel it off and cut it into small squares for transportation.

A good cement, that will render india rubber in any form adherent to glass or metal, is oft-times a desideratum with photographers, and in the "*Polytechnisches Journal*" there is a simple receipe given for the preparation of such a compound. Some shellac is pulverized, and then softened in ten times its weight of strong ammonia, whereby a transparent mass is obtained, which becomes fluid after keeping some little time, without the use of hot water. In three or four weeks the mixture is perfectly liquid, and, when applied, it will be found to soften the rubber. We are told that the rubber hardens as soon as the ammonia has evaporated again, and thus becomes impervious both to gases and to liquids. For cementing the rubber sheet, or the material in any shape, to metal, glass, and other such surfaces, the cement is strongly recommended.

The use of the salts of barium for adulterating goods sold by weight is on the increase. Some rubber goods have been found with these salts in the material, which on combustion left as much as 60 per cent. of ash, pure rubber leaving only 2.5 or 3 per cent. The adulterated goods cracked and lost their elasticity.

Rubber over-shoe making . * "*Scientific Amer.*," xxxv. 262.
Solvents . . . . . "*Scientific Amer.*," xxxv. 325.
Rubber stamps, making . "*Manuf. & Build.*," ix. 119.
* "*Manuf. & Build.*," ix. 143.

Rub'ber Cen'ter Spring. A car or vehicle spring with a caoutchouc cylinder or block inclosed in a spiral spring, or otherwise associated; as seen in several forms and instances in Figs. 1142–1144, pp. 482, 483, "*Mech. Dict.*"

Rub'ber Dam. (*Dentistry*). A shield of sheet rubber clasped around a tooth to exclude saliva during operation upon the tooth. See DAM, 3, *supra*.

Rub'ber Dam Clamp. See DAM CLAMP, Fig. 776, p. 245, *supra*; DAM CLAMP FORCEPS, Fig. 777, p. 245, *supra*.

Rub'ber Mop. The mop-head has a plate of thick rubber which is used as a scrubber or squeezer.

Rub'ber Pack'ing Ring. An annular gasket acting as a packing in many forms of pistons.

Rub'ber Spring. A spring of caoutchouc, in whole or in part. See instances in Figs. 1142–1144, pp. 482, 483, "*Mech. Dict.*"

Rub'ber Tu'bing. Impervious rubber tubing; may be made entirely impassable to coal gas by painting it over with a solution of silicate of sodium; otherwise known as water glass.

Rub'ber Tread. A step covering of vulcanized caoutchouc.

Rub'ber Wheel. A wheel with noiseless rubber tire.

Rub'bish Pul'ley. A simple form of tackle-block, used with a rope in hoisting materials from a foundation or excavation. A *gin-block*.

Ru'by Glass. (*Glass.*) Red glass. Made by repeated meltings with the addition of brown oxide of copper, oxides of lead and tin, scales of iron, and borax. The color is developed by repeated heatings with added quantities of the above coloring agents.

Rud'der. The principles governing the proportions and the amplitude of the circle described during its evolution, considered in article "*Gouvernail*," *Laboulaye's "Dict. des Arts et Manuf.*," tome iv., ed. 1877.

Jury rudder, *Cagliesi* . * "*Scientific American*," xxxv. 297.

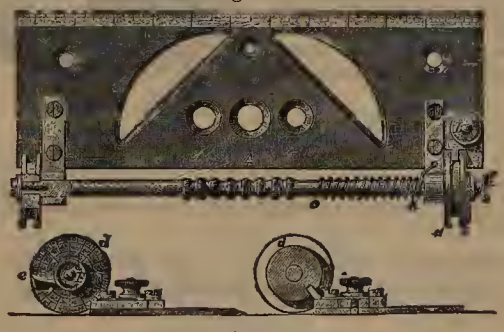
Cagliesi's rudder (Ancona, Italy) is collapsible, and is made with fan-like sections.

Rudder screw . . . * "*Scientific American*," xxxviii. 306.

Rud'der Wheel. (*Agric.*) A wheel in the rear of the share, assisting in bearing the weight of the plow, and, in some cases serving as a fulcrum in directing its course. See Fig. 704, p. 225, *supra*.

Ru'ler. Cousins' parallel ruler is intended for the purposes for which parallel rulers are commonly used, and for duplicating designs, curves, etc.

Fig. 2179.



Cousins' Parallel Ruler.

The plate *a*, which forms the body of the ruler, has formed in it two oppositely disposed segmental openings, whose

straight sides form an angle of 45° with the beveled edges of the ruler. It has also several small circular apertures, which may be utilized in forming curved lines.

Parallel with one of the edges of the plate *a*, a shaft, *c*, is journaled in suitable supports. On the ends of this shaft and outside of the bearings there are grooved wheels, *d*, which do not quite touch the surface on which the plate *a* rests.

To one of the wheels, *d*, is an arm, *e*, secured by the screw *f*, as shown in Fig. 2, and in the groove of the same wheel there is a pin that strikes the stop which is secured to the plate *a* by the screw *i*. This stop is arranged to engage the arm *e* also.

On the shaft *c* is placed a spiral spring, *k*, which returns the pin in the groove of the wheel to the stop on the plate *a*, as indicated in Fig. 3.

The side of the wheel *d* is graduated so that the arm *e* may be adjusted at any required distance from the pin in the groove. This distance governs the space between the lines formed along the edge of the ruler.

In drawing parallel lines the arm *e* having been adjusted as already described, the shaft *c* is pressed down until the wheels *d* touch the paper on which the lines are to be made; this tips up the beveled edge of the plate *a*. The instrument is now moved forward, by rolling the milled portion of the shaft under the fingers, until the arm *e* strikes the stop on the plate *a*, when the plate is allowed to regain its former position and the line is drawn. In drawing the successive lines the operation is repeated.

Section lining is done along the straight edges of the segmental openings, and curved lines are formed along the curved sides of the openings. Various designs may be duplicated by fastening patterns to the plate *a*, so that they will move with it.

Pattern makers use a rule whose divisions are made a certain per cent. longer than standard measure. Iron castings shrink in cooling about 1 per cent. or $\frac{1}{8}$ of an inch to the foot. The patterns require to be made proportionately larger. By using the rule $\frac{1}{8}$ of an inch in a foot longer than the standard, every measurement of the pattern is made proportionately larger without the trouble of calculation.

Desk rules are either flat, round, or hexagonal. The flat rulers have a beveled edge to avoid blotting the paper with ink flowing from the side of the pen. For adjustable and parallel rulers, see "*Mech. Dict.*," Figs. 4497, 4498, p. 2001.

An instrument for guiding a pen or pencil in drawing straight or curved lines.

Rule, spiral, *Fuller*, Br. . . . * "*Engineering*," xxvii. 257.
Parallel, *Cousin* . . . . . * "*Scientific Amer.*," xl. 118.
Kempe . . . . . * "*Teleg. Jour.*," v. 268.
Ruling pen, *Hoffman* . . . * "*Scientific Amer.*," xl. 150.
Drawing a straight line, *Kempe* * "*Sc. Am. Sup.*," 1340, 1352, 1364, 1383.

Rule Cut'ter. A machine for cutting to lengths rules and leads used in the composition of rule, column, or table matter.

Fig. 2180.

Rule and Lead Cutter.

The front gage is for cutting narrow strips or spaces, and the back gage is reversible, so that it may be set to cut to 9″ in length.

Ru'ling Machine'. William A. Rogers, of Cambridge Observatory, Mass, has a machine for ruling microscopic lines on glass. It will rule 80,000 parallel lines in an inch.

See paper by *Prof. Rogers*, in the "*Proceedings of the American Academy of Arts and Sciences*," where Nobert's plates are considered and the method of their production discussed. Also the modes of preparing diamond ruling-points. See NOBERT'S PLATES, p. 1531, "*Mech. Dict.*"

Run'ner. On the stick of an umbrella, the tubular piece to which the stretchers of the ribs are swiveled.

Higgins' automatic runner . . * "*Engineer*," xlii. 165.

Run'ning Board. (*Railway*). A board placed over the ridge or center of a freight-car roof, and extending the whole length of the car, and which is provided for train-men to walk or run on, in going from one end of a train to the other. — *Forney.*

Run'ning Trap. A depressed bow-shaped section in a pipe, forming a U, through which water passes freely, but the depression remaining filled with water, affords a seal.

Fig. 2181.

Bower's Sewage Running Trap.

AA — Inlet pipe connecting directly with the wash-stand, sink, or other fixtures.

B — Outlet pipe connectiug directly with the main waste-pipe.

C — Cup-shaped chamber which always remains filled with liquid up to pipe *B*, thereby floating the hollow rubber valve *D* firmly to the mouth of the pipe *A*, and making a perfect seal.

E — Is a small lug on the cup, to enable a person to screw and unscrew the cup easily.

F — Is a rubber gasket to prevent leakage from the joiuing of the cup to the body of the trap.

Rus'sian I'ron. The smooth, glossy-surfaced sheet-iron of Russia has been imitated in many quarters with varying success. Below we give one process, furnished by M. Koulibine, a Russian engineer: —

These polished sheets are manufactured from charcoal iron, produced in finery fires and brought into the form of blooms about one inch thick. These blooms are heated to cherry heat and rolled into leaves. Each of these leaves is cut into pieces corresponding to the weight of the sheets which are to be manufactured, and these pieces are piled upon one another and rolled together until the desired degree of thinness is attained. Thus the black sheets are manufactured. To transform these into polished sheets a certain number at a time are heated to red heat and piled one upon another, a black, impalpable powder, which is simply pulverized charcoal, being sprinkled between each two sheets. The bottom and the cover of each packet of sheets thus piled for polishing are formed by two sheets of greater thickness. This packet is then hammered for the purpose of reducing the sheets still further in thickness, under a hammer, the head of which weighs from 1,000 to 1,100 kilograms (say 2,200 to 2,400 lbs.). For giving polish and luster, the sheets, now almost cold, are brought under a second hammer with a large face, rounded at the edges and of the same weight. Finally they are allowed to cool completely, and are then clipped and classified into three classes, according to the perfection of their polish. The sheets of the first class ought to be like a mirror, without a spot upon their surface. The action of charcoal projected upon the red-hot surfaces, and inclosed between them without access of air, may be easily understood. It cements, and thus enables them to take a high polish, while rendering them at the same time less liable to rust. This cementation once having taken place, the sheet should not afterward be returned to the heating furnace Whether the non-oxidizable quality is due to a carburation of the surface by cementation or by an oxidation which has been supposed to take place in the somewhat tedious process of manufacture, is not yet fully decided. The high quality of the iron used by the Russians has no doubt much to do with the merited popularity their final product enjoys. In the same category is the fact that, while we make most excellent wire from our own iron, we have not yet been able to produce an article quite equal to the Swedish rods for certain purposes. We have no doubt but that in time the American product, or "imitation Russia," which is now perfectly adapted to many uses, will eventually be made equal in all respects to the genuine Russian and exclude it from our markets; but this result will only be accomplished by greater care and skill in manufacture.

See "*Mech. Dict.*," p. 2005.

Rust. It has usually been supposed that the rusting of iron depends principally upon moisture and oxygen. It would appear, however, from the late Dr. Calvert's experiments, that carbonic acid

is the principal agent, and without this the other agencies have very little effect. Iron does not rust at all in dry oxygen, and but little in moist oxygen, while it rusts very rapidly in a mixture of moist carbonic acid and oxygen. If a piece of bright iron be placed in water saturated with oxygen, it rusts very little; but if carbonic acid be present, oxidation goes on so fast that a dark precipitate is produced in a very short time. It is said that bright iron placed in a solution of caustic alkali does not rust at all. The inference to be derived is that, by the exclusion of moist carbonic acid from contact with iron, rust can be very readily prevented.

To take rust out of steel place the article in a bowl containing kerosene oil, or wrap the steel up in a soft cloth well saturated with kerosene; let it remain 24 hours or longer; then scour the rusty spots with brick-dust. If badly rusted, use salt wet with hot vinegar; after scouring, rinse every particle of dust or salt off with boiling hot water; dry thoroughly; then polish off with a clean flannel cloth and a little sweet oil.

Or brush with a paste composed of ½ oz. cyanide potassium, ½ oz. Castile soap, 1 oz whiting, and water sufficient to form a paste. The steel should first be washed with a solution of ½ oz. cyanide potassium in 2 oz. water.

Rust Ce-ment'. Make a stiff paste with 2 parts of sal-ammoniac, 35 parts iron borings, 1 part sulphur and water, and drive it into the joint with a chisel; or, to 2 parts of sal-ammoniac and 1 part flowers of sulphur, add 60 parts of iron chips, and mix the whole with water, to which one sixth part vinegar or a little sulphuric acid is added.

Or mix 100 parts of bright iron filings or fine chips or borings with 1 part powdered sal-ammoniac, and moisten with urine; when thus prepared, force it into the joint. It will prove serviceable under the action of fire. All the above parts are by weight.

Rust, Preserving Iron from. Dodé's method is to coat the surface to be protected with a thin film of borate of lead, having a little oxide of copper dissolved in it, and having also suspended in it bright scales of precipitated platinum.

A red heat is employed to fuse the composition, which is applied by brush or bath. The effect is to cover the iron with a thin, glassy coating of a bright gray tint, unaffected by sewer gases, dilute acids and alkalies, and the heat of a fire.

See article by *Stoffel* in "*Jour. Soc. Arts*," Br., 1879, republished in "*Van Nostrand's Mag.*," xx., p. 13 *et seq.*

Or, paint with melted caoutchouc, to which some oil has been added. The caoutchouc must be melted in a close vessel to prevent its burning, and should be frequently stirred.

Dr. Sterling's plan is to impregnate the structure of the metal while heated with a non-oxidizable substance, — say paraffine or mineral oil.

Barff's plan is to convert the surface into magnetic or black oxide. *Journal Soc. of Arts.*

Barff . "*Van Nostrand's Mag.*," xvi. 300; xviii. 350; xx. 450.
"*Iron Age*," xxv. January 22, p. 7.
Perry . "*Van Nostrand's Mag.*," xviii. 533.
Bower . "*Van Nostrand's Mag.*," xix. 90, 378.
Dodé . "*Van Nostrand's Mag.*," xx. 178.

See IRON PRESERVING PROCESS, p. 507, *supra*.

S.

Sa-bot'. The iron shoe or point of a pile.

Sa-bot' Ma-chine'. A machine for making the wooden shoes (sabots) extensively used in Europe.

The machines of M. Arbey, Paris, complete the shoe in three operations. The blanks first pass to the shaping machine, adapted to all sizes, where the shoe receives its shape. A second machine hollows the inside, while a third machine gives them the finishing touch and shapes the sole.

Sabot mach., *Arbey*, Fr. * "*Engineer*," xlvii. 255, 262.

Sac-char'i-fi-er. An apparatus for treating grain and potatoes by steam under high pressure, for converting the starch into sugar previous to the alcoholic fermentation.

The grain or potatoes are mixed in a boiler, with about three times their weight of water. Steam is then admitted in such a manner as to constantly stir the entire contents. When steam is admitted to the boiler, the air is allowed to escape through a valve. As long as the latter is kept open the water condensed within the boiler is allowed to run off. When the air has been forced from the boiler, all valves are closed. The material is then subjected to the combined action of heat and pressure for three or four hours, samples being taken from places provided, for inspection. At the end of that time the liquid is of a dark yellow color, and the starch has been completely converted into sugar, although the grains on the pieces of potatoes retain their original shape. Care must be taken to introduce the steam slowly, and to regulate the pressure carefully, or a portion of the sugar will be converted into caramel, unfit for the formation of alcohol. When this operation has been finished the mash is blown out, under pressure, into the mill, the solid particles crushed and the mashed formed into a thin paste possessing all the qualities necessary for the formation of alcohol.

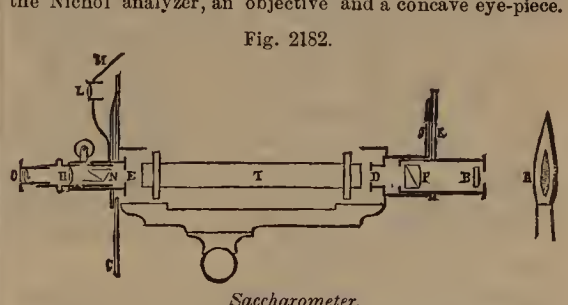
Sac'cha-rom'e-ter. An instrument for determining the value of sacchariferous juices.

The method of determining these values by means of the specific gravity will always find wide application because of its simplicity and satisfactory results.

The action of the saccharometer depends on the fact that ordinary light, when transmitted through or reflected by certain bodies, acquires certain properties which it did not before possess. Among other properties conferred upon the light is that of displaying gorgeous prismatic colors when caused to traverse certain liquids and crystals. These colors, when brought into view by means of a solution of cane sugar, are the more vivid as the solution is more concentrated.

In Laurent's new saccharometer the light from a fixed monochromatic yellow flame is passed through a diaphragm containing a plate of bi-chromate of potash, which absorbs the violet and blue rays. The yellow rays which pass it fall on a bi-refracting prism which turns on the longitudinal axis of the instrument, and in which the second image is diverged to one side and intercepted by diaphragms. One of these carries a thin plate of quartz parallel to the axis, which covers only one half of the diaphragm. Its thickness is one-half wave for the yellow rays. Between this diaphragm and a second one the testing tube containing the sugar solution to be tested is placed. In front of the second diaphragm is the Nichol analyzer, an objective and a concave eye-piece.

Fig. 2182.



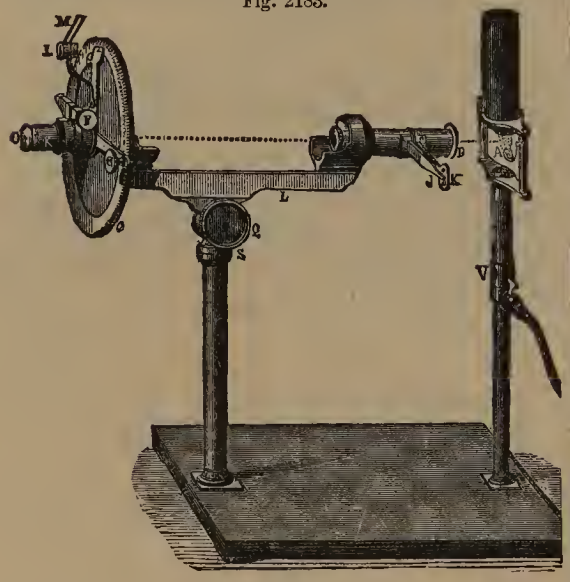
Saccharometer.

The latter three parts inclosed in a tube revolve, the angle through which they move being indicated on an alidade.

In Fig. 2182 *A* is a yellow monochromatic flame, placed at an invariable distance from the instrument. The burner is constructed so as largely to augment the intensity of the flame. *B* is a diaphragm containing a plate of bichromate of potash, which absorbs the violet and blue rays which exist in the flame, while allowing the useful yellow rays to pass. *P* is a bi-refracting prism, in which the second image is diverged to one side and intercepted by diaphragms. It turns on the axis *O E*. *D* is a diaphragm carrying a thin plate of quartz parallel to the axis, the thickness of which is one half

wave for the yellow rays. This is fixed and covers but the half of the diaphragm. *E* is another diaphragm: *N*, the analyzing Nicol; *H*, the objective; *O*, concave eye-piece. The system, *O H N*, is mounted on an alidade, which turns on the disk *C* around the axis *O E*. *T* is the tube containing the solution to be tested. *C* is a graduated disk having one or two divisions; one especially for sugar, the other in half degrees of the circle for any rotary substances. *L* is a lens for reading the scale. *M* is a mirror throwing the light of the burner on the divisions and thus obviating the need of any

Fig. 2183.



Saccharometer.

additional light. The new optical disposition consists in the polarizing system, which is composed of two distinct parts—the bi-refractiug prism *P* which turns, and the diaphragm *D* which with its half plate of quartz is fixed. In Fig. 2183 this diaphragm is represented enlarged, as it is seen on looking into the instrument. The left half is covered by the quartz plate, the axis of which is also parallel to the line of separation *O A*, and the right half being open allows of the passage without deviation of the polarized light from the polarizer *P*, Fig. 2182.

Thore . . . . . "*Technologiste*," xxxix. 38.
Laurent . . . . . * "*Scientific Am.*," xxxviii. 408, 181.
Dubosq . . . . . * "*Scientific American*," xxxix. 389.
Biot's polarizer . . . * *Laboulaye's* "*Dictionnaire*," iii., "*Sucre*," Fig. 3, etc.
Saccharometer, *Balling* "*Scientific American*," xli. 329.
Polarizing, *Laurent*, Fr. "*Iron Age*," xxii., July 4, p. 19.

Sack'er and Weigh'er. A spout with sliding door admits the grain or material to be weighed from the receptacle above. The bag is clipped by a ring to the funnel which is suspended from the back end of a suspended steelyard. When the amount the steelyards are set for is received into the sack, the slide is closed and the flow cut off.

Sack Hold'er. An inclined frame, braced against the floor, forms a rest for the sack in filling while a ring holds the mouth of the sack open and forms a rest for the vessel used in filling.

Sack Emp'ti-er. A contrivance by means of which through a winch, ropes, and capstan, a frame which holds the sack in filling is elevated and tipped to empty the sack.

Emptier . . . . . * "*Scientific Amer.*," xl. 19, Fig. 5.
Filler . . . . . * "*Scientific American*," xl. 19.

See also Bag Filler.

Holder . . . . . * "*Scientific Amer.*," xl. 20, Fig. 8.
Lifter . . . . . * "*Scientific American*," xl. 19.
Truck . . . . . * "*Scientific American*," xxxix. 323.

Sack Hold'ing Truck. One arranged to hold the sack in vertical position while being filled and having a hoop to hold the mouth open.

Sack Lift'er. 1. A sliding frame on which the sack rests, is elevated by means of a wincli to the proper height to shoulder, when the sack is filled.

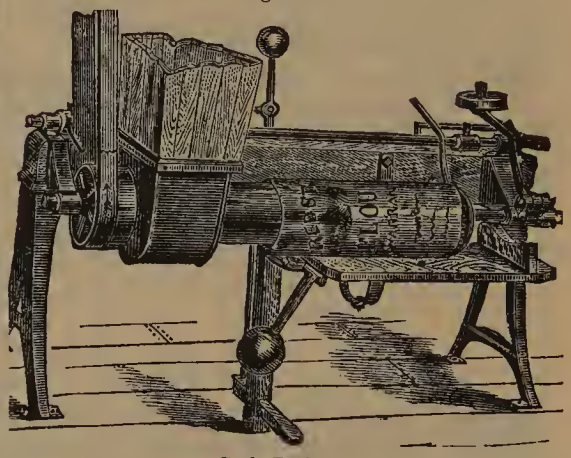
2. A clutch on the rope to catch the gathered end of a filled bag, and lift it up into the mill.

Sack lifters, emptiers, etc. . * "*Scientific American*," xl. 19.

Sack Pack'er. A machine for packing flour in sacks. See Fig. 2184.

The operator places the bag on the screw tube as shown in the engraving, and draws the piston head against the bottom of the bag. He then lifts the tumbling ball, by which movement the belt is shifted to the tight pulley starting the screw to packing the sack. While the bag is being filled the receding piston changes the belt to the loose pulley by means of the shifting rod, and thus stops the screw, enabling the operator to set the stop collar so as to put any amount of flour in the sack that may be desired. When the screw stops, the operator places his foot on the treadle, dropping the sack into an upright position ready for removal, and by this means catching the spill. The sack being removed, a weight returns the turning board to a horizontal position. When this

Fig. 2184.



Sack Packer.

device is used as a mixer, the conveyor flights on the screw pulverize the lumps and mixes in the passage through the horizontal screw tube, discharge being made into a bin below by means of muslin bag or hose.

By the use of reënforce rings on the end of the screw tube, bags of from 12 to 50 pounds' capacity can be packed without changing the tube. Its capacity is from 2 to 4 sacks per minute.

Fig. 2185.

Saddle.

Sad'dle. Fig. 2185 is a view of the saddle complete, with bag, used in the United States mounted service. No padding or raw hide is used. The round, smooth-cut pommel is made as low as possible to escape the highest withers, and the seat is long and flat, the cantle rounding very little. The trees are made by machinery to avoid inequalities, and the bearing surface made as long as possible to distribute the weight over the back of the horse, the whole length of the saddle.

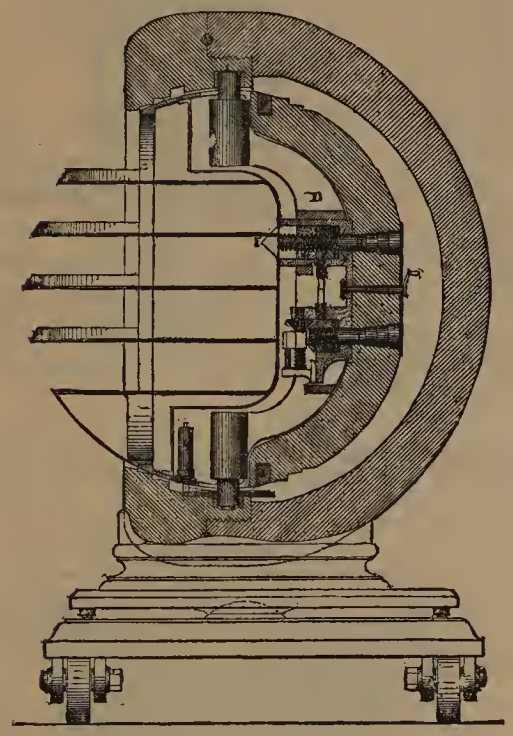
Sad'dle Brack'et. A bracket shelf in a stable or harness room to hold a riding saddle.

Sad'dle Clip. A clip which straddles the spring and axle, and the legs of which are secured by bolt nuts. Fig. 145, p. 61, *supra*, Fig. 150, p. 62, *Ibid.*

Safe. A receptacle where valuables may be deemed safe from attacks of fire, burglars, etc. Generally iron or steel cases, variously prepared. See "*Mech. Dict.*," pp. 2013, 2014, 2015.

Figs. 2186, 2187, are sectional views of the Corliss spherical revolving safe composed of an outer and inner shell, the latter revolving within the former, forming both the door and the receptacle for valuables. The outer shell forms about two thirds of a sphere, and is made in two parts, so that the

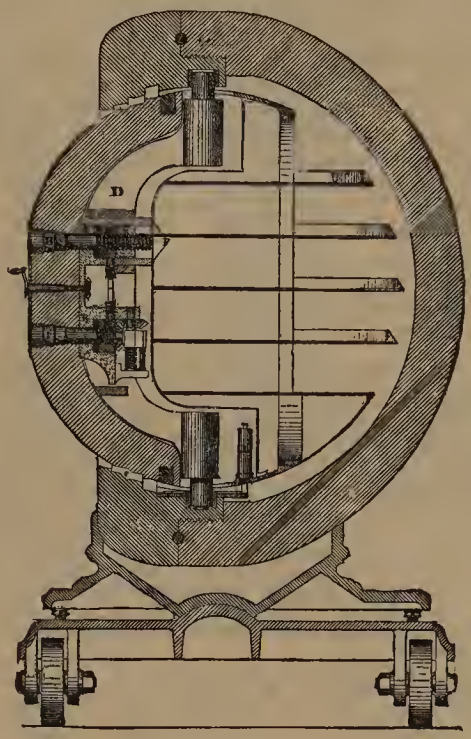
Fig. 2186.



Corliss Safe, Open.

inner part, called the safe, can be placed within it; these parts are screwed together, as indicated in section, by a screw the whole diameter of the safe. The jointing surfaces of these two parts are ground to an accurate fit, and screwed together like hose coupling, leaving no space between them and making the shell practically one solid piece of metal. The interior swinging part is also one solid piece of metal about four inches thick. The outside diameter of this sphere corresponds with the inside diameter of the larger one, and the joint between the spheres is formed by a series of steps which increase in diameter towards the interior of the safe. The joint is circular and is made an accurate fit, the outside steps being made by grinding, and the inner ones bored and turned by machinery adapted to the purpose. To guard against accidents this safe is always provided with two locks, either of which will open it. The locks may be set on the same or different combinations, and in case either lock should fail from any reason to operate, the safe can be opened by the other. Either time locks, or the ordinary combination locks are employed. The drawings sufficiently explain the inside arrangement and workings.

Fig. 2187.



Corliss Safe, Shut.

Safe, *Marvin*	* "*Scientific Amer.*," xxxviii. 82.
Safe alarm, *Koloseus* .	* "*Scientific American*," xxxix. 99.
Safe, fire-proof, submerged, *Gray* . . .	* "*Scientific American*," xxxv. 338.
Safe, provision, *Inman*	* "*Scientific American*," xl. 344.
Safes, history, invention, and manufacture of .	"*Iron Age*," xxi., Jan. 24, p. 5.
Safes, marine	* "*Scientific American*," xxxv. 179.
To blow open . . .	* "*Scientific American*," xxxvi. 244.

Safe'ty Ap'pa-ra'tus. For cages in mines, etc., article "*Parachute*," *Laboulaye's* "*Dictionnaire des Arts et Manufactures*," iv., ed. 1877.

Dobo. *Fontaine* *.
Claude-Perrault. *Nyst* *.
Machecourt.

Safety cylinder cock .	* "*Scientific American*," xliii. 35.
Disk	* "*Scientific American Sup.*," 1472.
Hook	* "*Scientific American Sup.*," 4011.
Lamp, *Coquillon* . .	"*Eng. & Min. Journal*," 23.
Stephenson	* "*Scientific American Sup.*," 742.
Davy	* "*Scientific American Sup.*," 742.
Odling	* "*Scientific American Sup.*," 2368.
Gildemeister & Kampe	"*Technologiste*," xli. 567.
Safety appar. for cages.	
Spitzberg Tunnel . .	* "*Engineering*," xxix. 395.
For mine cages.	
Cousin, Fr. . . .	* "*Engineering*," xxvi. 389.
Leonardt, Br. . .	* "*Engineering*," xxix. 58.
Safety catch for mine cages, *Cousin*, Fr. .	* "*Engineer*," xlvi. 223.
Elevator, *Burdon* . .	"*Manuf. & Builder*," ix. 121.
Lamps, *Davy*, ...	"*Lampe de Sûreté*." *Laboulaye's* "*Dict.*," ii. * 1375-76.
Roberts	"*Lampe de Sûreté*," *Laboulaye's* "*Dict.*," ii. * 1377.
Mesnil	"*Lampe de Sûreté*," *Laboulaye's* "*Dict.*," ii. * 1377.
Mueseler	"*Lampe de Sûreté*," *Laboulaye's* "*Dict.*," ii. * 1377.
Combes	"*Lampe de Sûreté*," *Laboulaye's* "*Dict.*," ii. * 1378.
Safety paper, bank checks	"*Scientific American*," xxxiv. 351.
Papier de Sûreté . .	*Laboulaye's* "*Dict.*," iii.
Safety Winch	See SAFETY CATCH; SAFETY HOIST; CAGE; ELEVATOR, etc.

Safe'ty Bolt. One in which the pin is locked in position by padlock or other device.

Safe'ty Brake. An attachment to a crane or other hoisting apparatus to control the rate of de-

scent of an object. It usually consists of a band on a drum, which by pinching opposes the rotation of the latter. See SAFETY HOIST.

Safe'ty Catch. A device to prevent the falling of the cage in the event of the breaking of the rope. Safety catches attached to the cage are held away from the guides while the weight of the cage hangs on the rope, are released and spring against the guides as soon as the strain is taken from the rope, either by its being broken or otherwise. A safety hook detaches the cage from the rope if it is hoisted too far, and "landing dogs" prevent it from being accidentally lowered or dropped into the shaft, when it has been once hoisted above them at the pit-head. See Figs. 4539–4541, "*Mech. Dict.*"

In Cousin's counterpoise catch, used in the Bernissat pits in Belgium, a wedge is forced into the loop encircling the guide-rope by a spring as soon as the hoisting-rope breaks. The wedge is made of wood, and is provided with steel points to insure its taking a hold on the guide-rope in case of an emergency. In ordinary hoisting the wedge is withdrawn and the loop slides freely on the guide-rope. In the counterpoise arrangement, the guide-rope is attached at the bottom of the shaft, but its upper end runs over two pulleys and carries at its end a series of counter-weights placed one upon another, attached by chains. As soon as the winding rope breaks the wedge seizes the guide-rope, which is drawn downward by the weight of the falling cage. This causes the counter-weights to be lifted one by one until the cage has come to a stop, thus avoiding any injurious tearing strain upon the guide-rope.

Safe'ty Chain. (*Railway.*) A chain to attach certain parts to prevent their becoming entirely detached in case of the parting of the main connections.

Among such are coupling chains of platforms, of the brake-rods, etc. — *Forney's "Car-builders' Dictionary."*

Safe'ty Cyl'in-der Cock. A safeguard against injury to a steam cylinder by an accumulation of water. The water of condensation is let out of the cylinder without waste of steam.

Safe'ty Disk. A disk of light sheet-copper is placed across the boiler between the steam and an escape-pipe. An over-pressure of steam fractures the disk and allows the escape of the steam through the pipe.

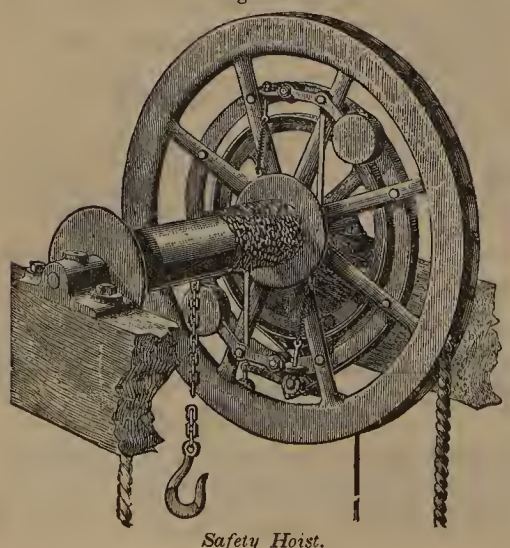
Safety disk for boilers, *Rowan*, Br. * "*Engineer*," xliv. 148.

Safe'ty Hang'er. (*Railway*). A metallic loop to prevent the falling of a rod in case of breakage.

Among such are those for brake-rods, etc. — *Forney.*

Safe'ty Hatch. A form of safety hatch for elevators, to close the hatchway when the cage is not in the act of passing. The doors are automatic, being pushed aside by oblique bars above the cage in ascending, and by similar bars beneath the cage in descending. The doors are returned by counter-weights. The safety attachment may be seen in detail in CAGE, ROPE ELEVATOR, SAFETY STOP.

Fig. 2188.



Safety Hoist.

Safe'ty Hoist. In Fig. 2188 the safety brake is applied automatically by the governor within the rim of the sprocket-wheel, so that the load, once started down, it is left to itself while the operator gets the next load ready.

Safe'ty Hook. In mines, a hook arranged to clutch a support and hold the cage, should the hoisting rope break through overwinding.

Safe'ty Lamp. A lamp to prevent explosions from fire-damp. See "*Mech. Dict.*," p. 2016.

Coquillon utilizes the property possessed by palladium, of remaining red-hot in a mixture of gas and air at the expense of the compound, in the construction of miners' safety-lamps. The lamp cannot cause an explosion without the palladium giving timely warning.

Dubrulles has invented a lamp which cannot be opened without extinguishing the flame.

Safety lamp.
Boullenot, Fr. . . . "*Van Nostrand's Mag.*," xiv. 572.
Safety lamps, ou, *Bagot* "*Engineering*," xxvii. 423.
Davy, * . . . . . "*Engineering*," xxvii. 423.
Clanny, * . . . . "*Engineering*," xxvii. 423.
Stephenson, * . . . "*Engineering*," xxvii. 423.
Mueseler, * . . . . "*Engineering*," xxvii. 432
Williamson, * . . . "*Engineering*," xxvii. 423.
Clanny, * . . . . "*Engineer*," xlvii. 341.
Davy, * . . . . . "*Engineer*," xlvii. 341.
Stevenson, *. . . . "*Engineer*," xlvii. 341.
Mueseler, * . . . . "*Engineer*," xlvii. 341.
Williamson * . . . "*Engineer*," xlvii. 341.
Davy . . . . . "*Scientific American Sup.*," 1720.
Dinant, Fr. . . . . * "*Engineering*," xxvi. 389.
Hydrostatic, *Kendall* "*Scientific American*," xxxvi. 210.
Odling, Br. . . . . * "*Engineer*," xlvi. 179.
Shakespeare, Br. . . * "*Engineer*," xlix. 173.
Williamson . . . . "*Scientific American Sup.*," 2149.
Williamson, Br. . . "*Iron Age*," xxii., July 4, p. 19.
Miner's . . . . . * "*Scientific American Sup.*," 2718.

Safe'ty Link. A device, a substitute for the safety or check-chains which couple cars to their trucks. Invented by *Thompson.*

* "*Railroad Gazette*" . . . . . viii. 117.

Safe'ty Loop. One of the loops by which the body-strap of a vehicle is attached to the body and perch to prevent dangerous rolling of the body.

Safe'ty Pa'per. In addition to what has been stated on page 2017, "*Mech. Dict.*," where about thirty distinctive processes are cited, an improvement in the manufacture of paper for bank notes, bonds, checks, etc., by Mr. Geo. W. Casilear, Superintendent of Engraving, U. S. Treasury Department, may be mentioned.

"This invention relates to the manufacture of bank-note and other commercial paper by coloring the pulp contained in separate compartments with different coloring matter, or by the use of different colored fibrous substances while in the pulp, contained in separate compartments.

"The pulp, having been prepared in the usual manner, is emptied into chests or tubs corresponding in number with the kinds or distinct colors of fiber desirable to be used in making the paper. From thence it is delivered into the compartment vats, each compartment being assigned for a color or alternate color, silk fiber, or other suitable material desirable for making distinctive paper. At the top of the vat is a series of gates, by means of which the flow of pulp is regulated as it passes over the trough and lip and falls upon the endless wire or web. The trough and lip is also subdivided by using thin partitions of brass, to correspond in number and to connect with the compartment-partitions of the vat. The operation being now apparent, the pulp of two or more colors passes over the lip or ledge in separate streams, the colors being divided by the thin partitions in their passage, and unite as they fall upon the endless wire, upon which it forms itself into paper of colored stripes or other material, composed of whatever character of pulp is used in the compartment-vat, desirable for making distinctive papers."

Bank-note paper, Br. . . "*Scientific American Sup.*," 1293.

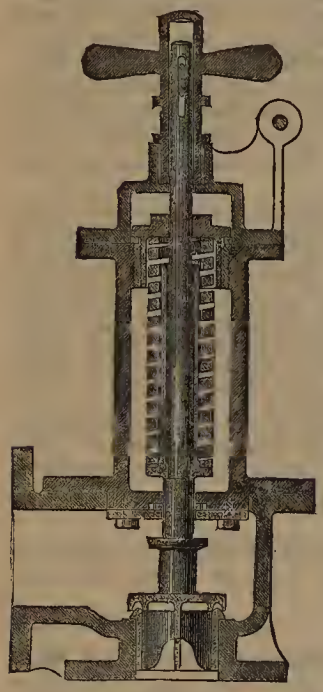
Safe'ty Pin. 1. A temporary pin in a percussion fuse, to prevent the plunger from striking accidentally against the percussion powder. It is held in place by a wire which is ruptured by a weight attached to it when the gun is fired. Fig. 17, p. 523, "*Ordnance Report*," 1877.

2. A garment pin bent on itself, and having a loop which retains the point shut and prevents pricking.

Safe'ty Valve.

Fig. 2189 is a form of valve much used on leading steamships. The peculiarity of the valve cousists in the grooved seat V, which has the effect to augment the area at the moment the valve lifts. The result is the valve will blow off to its maximum capacity with an increase of but two or three pounds' pressure in the boiler, and will close tight the moment the pressure falls a couple of pouuds below that to which the valve is loaded.

Fig. 2189.

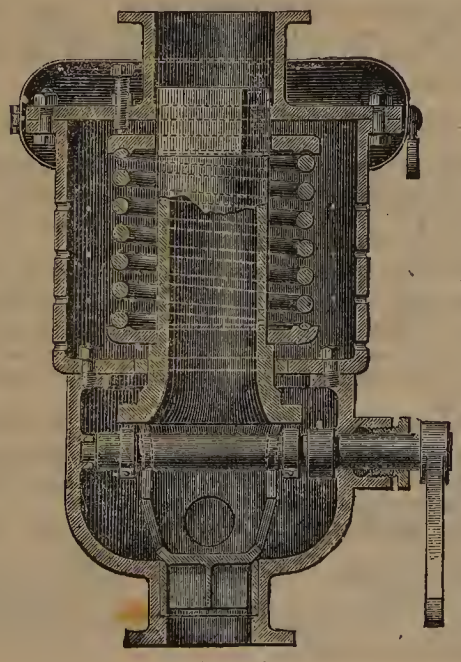


Safety Valve.

In Fig. 2190 the outlet for the steam is carried through the center, and the pressure is always perfectly fair on the valve, there being no side-action whatever, thus rendering the valve very sensitive, aud equalizing the wear.

Fig. 2191 is especially adapted to steam fire-engines, where quick stoppages are necessary. Should the safety valve be set to blow off at one hundred pouuds, and it be necessary to stop the engine with only fifty pounds of steam in the boiler, it will not be necessary to wait until the steam rise to one hundred pounds, but the wheel *h* is given a half turn up against the valve-spindle *g*, where it will remain and the steam blow off until the wheel *h* is turned back, and the valve resumes its seat again without derangement or altering the tension of the spring so that the steaun will blow off at one hundred pounds, the same as before

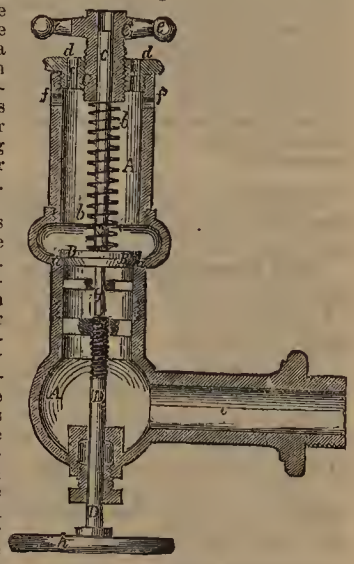
Fig. 2190.



Safety Valve.

Ashcroft's valve has a hollow semi-circular ring on the conical part. The lower seat of the valve has a corresponding aunulus at its top, somewhat larger than the one in the valve proper. When the valve is lifted to a slight extent, the steam is momentarily arrested in this spacc, thus producing a greater pressure, and lifting the valve to a greater height, similar to Fig. 2189.

Fig. 2191.



Steam Fire Engine Valve.

Blake's safety valves are globular, and the orifices are annular. They require no guide-wings or pins, and can oscillate freely on their seats, and are not likely to stick, as they cannot wedge themselves down in the seatings, whilst it is claimed they have nearly double the discharging power of an ordinary valve of the same diameter, and that with a lighter weight on them. The usual sizc of valve made by Mr. Blake has a $3\frac{1}{4}''$ outside seating and a $2\frac{3}{4}''$ inner one. Thus the discharging power of this valve equals an ordinary valve, $6\frac{1}{4}''$ diameter, while the weight required to load it to 60 lbs. per square inch is only 220 lbs., whereas a $6\frac{1}{4}''$ valve would require 1,840 lbs. to load it.

Safety valve, 6 kinds	* "*Sc. American*," xxxvi. 99, 353.
	* "*Manuf. & Builder*," xi. 65.
	* "*Sc. American Sup.*," 1527, 3742.
Adams, Br.	* "*Technologiste*," xli. 707.
	* "*Scientific American Sup.*," 802.
Eaves	* "*Scientific American Sup.*," 2239.
Fletcher	* "*Scientific American Sup.*," 690.
Schmid	* "*Scientific American Sup.*," 690.
Test	* "*Scientific American Sup.*," 690.
Wilson	* "*Mech. Dict.*," Fig. 1622, p. 554, *supra*.
Stone	* *Ibid.*, 1623, p. 555.

See Lock-up Safety Valve, * Fig. 2983, p. 1342, "*Mech. Dict.*;" Safety Valve, *Ibid.*; Test Safety Valve, *infra*. *Cf. Buel's* "*Safety Valves*."

Safety valves, *Adams*, Br.	* "*Engineer*," xlii. 254.
Blake, Br.	* "*Engineer*," xlii. 273.
Japanese Corvettes, *Penn.*	* "*Engineering*," xxiii. 286.
Klotz	* "*Engineer*," xliv. 67.
Safety valve, *Ashcroft's*	* "*Manuf. & Builder*," xi. 244.
Eave, Br.	* "*Engineer*," xlvi. 57.
	* "*Engineering*," xxvii 466.
Hudson	* "*Railroad Gazette*," viii. 263
Klotz	* "*Engineer*," xlix. 358.
Martyn-Roberts, Br.	* "*Engineer*," xlviii. 163.
Melling, Br.	* "*Engineering*," xxii. 510.
Schmid	* "*Engineering*," xxii. 214.
Schmidt	* "*Scientific American*," xliii. 386.
Schmidt, Switz. "Sentinel."	* "*Engineer*," xlvi. 209, 248.
Summerson, Br.	* "*Engineer*," xlii. 368.
Turnbull, Br.	* "*Engineering*," xxv. 522.
Lock-up, *Robey*, Lond.	* "*Scientific American Sup.*," 2050.
Marine, *Fletcher*, Br.	* "*Engineer*," xlii. 147.
Bailey, Br.	* "*Engineer*," xlii. 191.
Spherical. *Nasmyth*, Br.	* "*Engineering*," xxii. 393.
Spring, *Atcock*, Engl.	* "*Scientific American Sup.*," 855.
Spring-loaded. *Atcock*, Br.	* "*Engineering*," xxii. 363.
Test, "Rover." Br. Navy	* "*Engineer*," xlii. 145.
Form and principles	* "*Scientific Amer.*," xxxviii. 314.
Lubricator. *Pickering*, Br.	* "*Engineer*," xlii. 145.

Safe'ty Valve, Noise'less. Baird and Allen have patented an arrangement for obviating the noise of escaping steam.

The devices are an expansion chamber and an annular nozzle placed in the locomotive chimney, the effect of which is to produce a regular noiseless escape of steam, instead of

an intermittent and sonorous one as at present. The steam from the cylinders, instead of passing directly through nozzles, is discharged into a chamber of ten times the capacity of the cylinders, which will allow the steam to expand in volume and greatly reduce its pressure, so that the noise of puffing will not be heard more than ten feet away.

The Ashton Noiseless Blow-back Safety Valve, is claimed to do away with the din of the steam escaping from ordinary locomotive pop valves, at the same time effecting a considerable saving of fuel. It is so arranged that when the boiler is eased from overpressure, the escaping steam is conducted either to the feed water in the tender, to a muffler, or to the smoke-stack.

Sa'fre. (*Glass.*) The usual French name for the crude oxide of cobalt used as a blue in glass-making. See ZAFFER; COLORED GLASS.

Sail Sew'ing Ma-chine'. A large-sized sewing machine with extensive table for sewing widths of duck to form sails. Used also for sewing sack, bags, tarpaulins.

Sews straight or zig-zag stitch, with dry or tarred twine. Is made single or double, in the latter case to run two seams at ouce.

Sal'a-man'der. 1. A mass of waste metal from a break in a metallurgic furnace.

2. A cooled mass of metal and ciuder in a blast furnace in which the contents have proved refractory and the fire has died out.

Account of blasting a salamander with dynamite. "*Iron Age*," xvii., April 20, p. 9.

Sal Am-mo'ni-ac Bat'te-ry. (*Electricity.*) One in which chloride of ammonium is used as an exciting liquid. See LECLANCHÉ BATTERY.

A *bagration* battery is one in which the elements are immersed in a jar filled with earth sprinkled with sal ammoniac. — *De la Rive.*

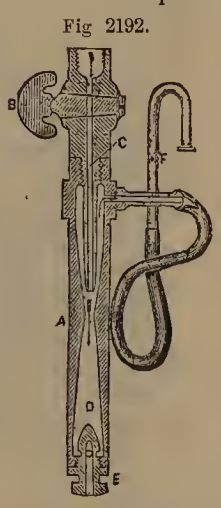
Sa-lam'pore. (*Fabric.*) A blue cotton cloth formerly made at Nellore in India, and largely exported to the West Indies, where it was the usual slave cloth.

Sail'ing Car. A car similar to a hand-car (minus the operatiug devices), is rigged with sail similar to that of au ice-boat and used on the railroads on the plains, by telegraph repair parties and others, have attained a speed of from 30 to 40 miles an hour. Sailing chariots were tried in Holland and other countries, more than two hundred years since, but labored under too many difficulties to come into common use.

Sal'i-nom'e-ter. An instrument for testing the strength of a brine or salt pickle. See "*Mech. Dict.*," page 2022.

Sa-li'va E-jec'tor. An instrument for carrying off the accumulating saliva in dental operations. In Fig. 2192, the end of the saliva tube *F* is inserted in the mouth of the patient, and a jet of water under pressure passed through the narrow throat of the instrument in the direction of the arrows, drawing the saliva into the vacuum chamber *D*, and out through the end. The check valve *E*, sets the water back in such mauner as to close the throat to the external air and produce a vacuum in the chamber above.

Fig 2192.



Saliva Ejector.

Sa-li'va Pump. For withdrawing saliva from the mouth during dental operations. See "*Mech. Dict.*," p. 2023.

Salt Man'u-fac'ture. The mauufacture of salt and bromin is carried on very extensively in the Ohio Valley. The salt is shown by chemical analysis to be the purest in America, and its perfect freedom from lime renders it very desirable for dairy use. The salt water is obtained by boring wells from 800 to 1,000 feet through a variety of soil, solid rock, and usually two stratas of coal. It is first pumped into a wooden cistern to settle, then run into iron pans, and boiled until ready for crystalizing, then drawn off into wooden grainers, through which copper pipes of 3 or 4 inches in diameter, filled with steam, pass the entire length of the grainer, heating the brine to an equal temperature. The salt crystals form on the surface, and are prevented from adhering firmly by mixing a small quantity of butter or tallow, which separates them, and they gradually fall to the bottom of the grainer and become salt proper. It is then lifted on platforms by workmen, and left to dry for 12 hours, after which it is packed into barrels, weighed, and ready for market. The salt analyzed shows: Sodium chloride, 97.5; Moisture, 2.0; Foreign matter, .5.

From the waste, or mother-water of the salt works, bromin is extracted, and forms an extensive article in trade, selling at one time for $9 per pound, the specific gravity being about three times that of water. There are six bromin factories in this locality, and when all are in operation they control the price of the foreign market. However, bromin, like all other merchandise, has shared in the decline, and is now sold for 34 cents per pound. The increasing demand for the article for medicinal purposes, and by chemists, dyers, and photographers, has made it a source of immense profit. Large quantities are annually exported.

For apparatus, see "*Mech. Dict.*," 2023, and *Laboulaye's* "*Dictionnaire des Arts et Manufac.*," tome iii., article "Sel."

Salt manufactory, Mich. * "*Scientific American Sup.*," 1621.

Salt Mill. For pulverizing the coarse salt into table salt.

Salt-pe'ter Man'u-fac'ture. The process of securing the saltpeter from the crude uitrate of potash.

Saltpeter manufacture . "*Scientific American*," xxxiv. 5.

Salt-pe'ter and Sul'phur Grind'ing Mill. (*Gunpowder.*) A machine for grinding and incorporating these ingredients in the manufacture of gunpowder. It consists of two-edge wheels in an annular pan: the Chilian mill.

See "*Ordnance Report*," 1879, Appendix I.: Plate I., Fig. 2, and description on p. 98.

Salt-pe'ter, Sul'phur, and Char'coal Mix'ing Reel. (*Gunpowder.*) An incliued cylindrical reel, like a flour bolt, used to sift the combined materials.

See "*Ordnance Report*," 1879, Appendix I., Plate I., Fig 3, and description on p. 99.

Sam-mi'er. (*Leather.*) A machine for pressing water from skins in the process of tanning.

Sam'ple Case. A case for carrying aud displaying quality of goods to be inspected.

Sample case, *Davis* * "*Scientific American*," xl. 372.

Sam'ple Cut'ter. A species of rotary shears. A sharp edged disk on a table rolling against an edge and cutting narrow strips of cloth from the roll, to form tailor's or traveler's samples. *Dartois*, French.

Sam'ple Scale. A finely balanced lever scale weighing one pound by $\frac{1}{10000}$. Used for weighing articles in bulk by accurately weighing small proportional quantities.

Sam'ple Spig'ot. A small faucet in the head of a cask.

Sand Band. (*Vehicles.*) A metallic ring on the inside of the hub, extending over a portion of the axle aud designed to keep sand and mud from entering the axle-box.

Sand Bar. A bank formed by the settling of sand or silt when one stream empties into another, or a river into the sea. Mode of removing, *Boulogne sur Mer*, * "*Scientific American Sup.*," 1554.

Sand Ap-pli'ance.

Sand auger . . . . . * "*Min. & Sc. Press*," xxxvii. 305.
Sand blast, *Tilghman* . * "*Manuf. and Builder*," viii. 160, * 181, * 205, * 229.
Sand brake.
Wiseman, India. "*Engineer*," xlviii. 73.
Sand and cinder sifter.
Chambers . . . . * "*Manuf. & Builder*," ix. 5.
Sand and gravel separator, *Chambers* . . * "*Scientific American*," xxxv. 163.
Sand distributor.
Chambers . . . . . * "*Engineer*," xlix. 438.
Sand-drying furnace . * "*Engineering*," xxiii. 502.
Sand-papering machine,
Flexible, *Fay* . . . * "*Engineer*," xlv. 435.

Sand Bat'te-ry. (*Electricity.*) A battery in which the elements are imbedded in cells filled with silicious sand saturated with dilute sulphuric acid.

Sabine, London, 1867 . . . . . 228.

Sand Brake. An automatic method of stopping a train when the speed exceeds a desired rate, or when cars are detached accidentally.

In Wiseman's automatic sand brake on the axle of every wheel of the train is placed a cylinder, in which a circular plate, keyed to the axle and bearing a number of small blades, revolves whenever the train is in motion. The blade compartment surrounds a cylindrical compartment, which, being filled with sand, is called the sand-box. The upper and the lower portion of this box are in communication with the blade-box by a number of parts, of which the lower can be opened and closed by means both of an electrical mechanism and automatically, while the upper ones, which are smaller, are always open. A plate, keyed to the axle, opens the lower sand-ports with every revolution, but the sand thus escaping is so small in quantity that it is immediately swept back by the blades into the sand-box through the upper ports. As soon, however, as the electrical circuit, which also controls this sand valve by means of an electro-magnet, is broken, the sand flows from the box very quickly, and, packing the blade-box, stops the train. The same will occur as soon as the train moves too rapidly, or when one or more cars are left behind. It is therefore automatic, and its effect increases with the velocity of the train.

Sand Dry'er. For evaporating the moisture.

Two perforated cylinders, one inside of the other. The inner cylinder is perforated at an angle of 45°, and inclosed with a conical top. The outside cylinder is perforated at about 40°, and both cylinders set perpendicular. A blower forces hot air into the inner cylinder, which, striking the conical top, is forced through the perforations, and passes through the sand placed between the cylinders. The outside perforations permit evaporation.

Sand Fence. (*Hydraulic Engineering.*) An obstruction to a current, made of stakes placed A-shaped and driven, and having brush lashed or wired thereto.

Sand-hold'er. A chamber in a pump-stock in which the sand carried by the water is allowed to deposit before reaching the pump-bucket or plunger.

Sand-pa'per-ing Ma-chine'. 1. (*Boot and Shoe Making.*) A drum covered with sand-paper for giving the desired surface to shoe-soles.

2. (*Wood-working Machinery.*) A machine for scouring, finishing, and polishing flat surfaces of wood.

Sand-papering mach., *Fay & Co.* * "*Scientific Am.*," xl. 89.

Sand Pump. A pump for ejecting sand.

The most notable instances are those of the great bridge pier caissons at St. Louis and New York. The discharge of the sand pumps at the east abutment of the New York and Brooklyn Bridge was over 346 cubic yards in 24 hours.

The general arrangement consisted of a water jet discharging upward through the center of a hollow globe; this globe was placed in the caisson at the bottom of an iron tube which extended upwards through the masonry, and was connected with a flexible tube below; the lower end of the flexible tube was kept submerged in the water below the level of the bottom of the caisson, and this water was drawn upwards by the inducing force of the jet, carrying with it a large quantity of sand; the general arraugement was not unlike that of the Giffard injector.

In sinking the Pier No. 5 of St. Charles Bridge over the Missouri River, Eads' sand pumps removed 18 cubic yards of sand per hour each. They were found to work best with a three-inch discharge-pipe and 200 lbs. per square inch water pressure. Three Cameron pumps, with 12″ × 24″ steam, 6″ × 24″ water cylinders were used to supply two of the sand pumps, and were worked up to their full capacity in so doing.

Sand Screen. A sand sifter.

San'i-tas. Russian turpentine and water are placed in huge earthenware jars, surrounded by hot water. Air is driven through the mixture in the jars continually for three hundred hours, the result being a decomposition of the turpentine, and the formation of a watery solution of the substance, to which Dr. Kingsett, the discoverer, has given the name of "Sanitas." After evaporation, the substance, as sold in tin cans, is a light brown powder, of a pleasant taste and odor, and capable in a very remarkable degree of preventing or arresting putrefactive changes. This new disinfectant has been in use for some time in England, and is highly spoken of. It is said to have a pleasant odor, is not poisonous, and does not injure clothing, furniture, etc. For household uses it would seem to be well adapted.

Sa-pon'i-fi-er. An apparatus for the manufacture of glycerine and the fatty acids, by the decomposition of fats and the isolation of their several constituents; stearic, margorinic, and oleic acids and glycerine.

Droux . . . . . * "*Scientific American Sup.*," 2562.

Sap Spout. A device for holding the bucket to the tree and conducting the sap from the tree to the bucket in sugar-making.

In the Eastern States the first flow of sugar-bearing sap which precedes the bursting of the leaf-buds, is specially called "sap." In Ohio and the West it is called "sugar water," and the later juices, which arise in the tree after the "sugar water" has ceased to run, are called the "sap."

Lawrence . . . . . * "*Scientific American*," xxxv. 325.

Sar'dine Shears. A pair of strong scissors, with pointed blades for cutting open the tin boxes containing sardines, potted meats, etc.

Sash Clamp. A clamp for squaring sash and tightening up the joints.

See Blind Clamp, Fig. 326, p. 106, *supra*.

Sash Cramp. A vise for holding sash while putting together.

See Flooring; Carpenters and Joiners' Clamps, "*Mech. Dict.*" and *supra*.

Sash Lift. A handle on a sash for lifting it.

Sash Tools.

Fig. 2193.

Sash, Blind, and Pin Tools.

1. Blind slat chisel for stationary slats.
2. Hollow auger, for rounding slat tenons.
3. Double chisel, for sash bars.
4. Staple punch, to prick both rods and slats.
5 Pin tool, for making pins.
6. Tool, for pointing pins.
7. Burr, for rounding slat tenons.
8. Center bit, for blind boring.

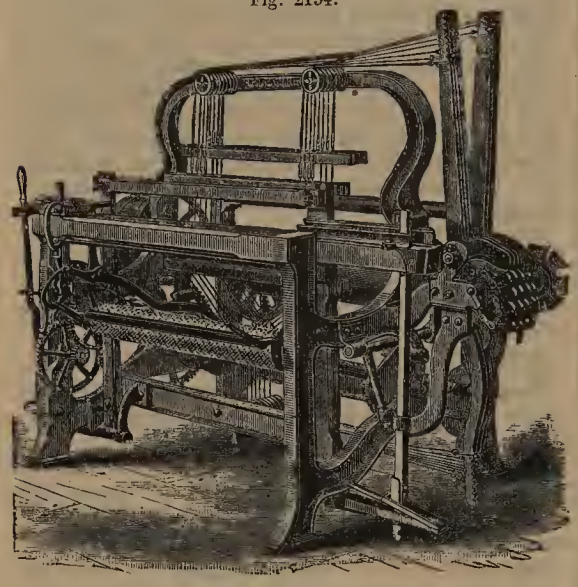
Nos. 1, 3, 4, and 5 may be used in foot-mortising machines. Nos 2, 7, and 8 in the blind stile boring machine, and small boring shaft.

Sash Rel'ish-ing Ma-chine'. A machine for forming that part of the shoulder of a tenoned piece which projects beyond the part which enters the mortise. This is done at one operation by a cluster of circular saws, part of them set longitudinally of the stuff, with smaller ones set transversely, the front teeth of the small ones being almost in conjunction with the front teeth of the two outside larger teeth, but a little in front.

Sa-tine'. (*Fabric.*) An all-wool French goods with satin weave.

Sat'in-et Loom. A loom designed for heavy goods, such as satinets, twills, jeans, satin stripes, checked cottonades, etc. It usually has 4 boxes at

Fig. 2194.



Satinet Loom.

one end. An endless chain governs and moves the heddle levers and is readily changed to any pattern without the aid of cams. It is of the open-shed type.

The cut shows a plain lathe, single shuttle loom.

Sat'in-ing. (*Fine Art Metal-working.*) A mode of decorating silver-ware by abrading the surface with a wire brush, which is revolved while the object is pressed against it. Soapy water is dripped upon the surface under treatment, the minute scratches giving the sheen of satin.

Sat'in Weave. (*Weaving.*) A style of weaving made on a loom with 5 or more harnesses. See ARMURE.

Sau'sage Ma-chine'.

See STUFFER, Figs. 1105, 1106, p. 359, *supra*.
See CUTTER, Fig. 4587, p. 2032, "*Mech. Dict.*"
See FILLER, Fig. 4588, p. 2032, *Ibid.*
See STUFFER, Fig. 4589, p. 2032, *Ibid.*
See MINCING KNIFE, Fig. 3168, p. 1446, *Ibid.*
See MEAT CHOPPER, Figs. 3106, 3107, p. 1415, *Ibid.*
See MEAT CUTTER, Figs. 3109, 3110, pp. 1415, 1416, *Ibid.*
See MEAT CHOPPER, Figs. 1699, 1700, pp. 590, 591, *supra*.
See MEAT ROCKER, Fig. 1702, p. 591, *supra*.

Saw. (*Surgical.*) A large number of varieties of surgical saws are included in the list of saws. p. 2035, "*Mech. Dict.*" See under the following list, which embraces the more important in segregated form: —

Amputating.	Capital.
Bead.	Chain.
Bow.	Circular.
Exsecting.	Maxillæ.
Folding.	Metacarpal.
Heine's.	Post-mortem.
Hey's.	Rachitome.
Interosseous.	Rotating.
Lifting back.	Subcutaneous.

1. Circular saws were first used in Holland. — *Richards.*

The proper periphery velocity of a circular saw is 9,000′ per minute, or 100 miles per hour. A saw 12″ in diameter should make 3,000 revolutions per minute.

A saw-blade exhibited by Jessop & Sons at Paris, was 10′ 8″ diameter, 9-16″ thick, and weighed 2,638 pounds.

See "*Mech. Dict.*," pp. 2033-2046.

Saw, *Simonds*	"*Iron Age*," xxii., Aug. 15, p. 5.
Saw bench, *Casson* . .	* "*Scientific American*," xxxix. 374.
Casson, Br.	* "*Engineering*," xxvi. 342.
Circular, *Wardwell* .	* "*Man. & Builder*," xii. 79.
Saw file guide, *Roth*. .	* "*Man. & Builder*," xii. 78.
Saw guard, *Garrett*, Br.	* "*Engineering*," xxviii. 446.
Lakeman, Br. . . .	* "*Engineer*," xlviii. 404.
Circular, *Dale*, Br. .	* "*Engineer*," xlix. 268; l. 229.
Saw guide, *Roth* . .	* "*Man. & Builder*," x. 225.
Saw gummer, *Densmore*	* "*Man. & Builder*," xii. 25.
Disston	* "*Engineer*," xli. 450.
Tucker	* "*Scientific American*," xli. 86.
(Emery), *Densmore* .	* "*Scientific American*," xxxv. 54.
Saw-mill, American . .	* "*Engineer*," l. 183.
Portable. "Canadian"	* "*Scientific American*," xxxv. 318.
Saw-mill dog, *Stearns Co.*	* "*Scientific Amer.*," xxxviii. 198.
Saw, perforated blade.	
Am. Saw Co. . . .	* "*Engineer*," xli. 447.
Saw set, *Jones*	* "*Iron Age*," xx., July 26, p. 5.
Saw straightening . .	* "*Scientific American*," xxxvi. 259.
Saw tooth, *Hoe* . . .	* "*Scientific American*," xxxv. 294.
Saw, insertable tooth.	
Am. Saw Co. . . .	* "*Engineer*," xli. 447.
Hoe	* "*Min. & Sc. Press*," xxxvi. 257.
Schley	* "*Scientific American*," xxxix. 406.
Saws, *Boynton*	* "*Iron Age*," xvii., June 6, p. 17.
Disston	* "*Iron Age*," xvii., June 6, p. 29.
	* "*Engineer*," xli. 447.
Scroll saw, *Bentel, Margedant & Co.* . . .	* "*Manufact. & Builder*," viii. 105.
Trump	* "*Manufact. & Builder*," viii. 112.
Beach	* "*Manufact. & Builder*," viii. 222.
Bentel	* "*Scientific American*," xxxiv. 179.
Bush	* "*Scientific American*," xxxv. 262.
Beach	* "*Engineer*," xli. 428.
"Boss"	* "*Iron Age*," xxii., Oct. 24, p. 5.
"*Dexter*"	* "*Scientific American*," xxxvi. 275.
Dexter	* "*Iron Age*," xviii., Nov. 30, p. 1.
"Eureka," *Woods* .	* "*Manufact. & Builder*," ix. 241.
Fay	* "*Manufact. & Builder*," ix. 217.
Griffin	* "*Scientific American*," xl. 150.
Lester	* "*Iron Age*," xxi., May 2, p. 25.
Lewis	* "*Scientific Amer.*," xxxvii. 390.
Plummer	* "*Iron Age*," xvii., April 13, p. 3.
	* "*Scientific American*," xxxiv. 6.
"Stafford"	* "*Scientific Amer.*," xxxviii. 217.
Stafford	* "*Iron Age*," xxi., March 21, p. 20.
Walker Bros	* "*Scientific Amer.*," xxxvii. 227.

Saw Bra'zing Forge. A forge for brazing the ends of a band or other saw, having an anvil piece with blowing furnace below.

Saw Bench. The bench on which the material rests in being worked.

Fig. 2195 shows the table of a combined cutting-off saw, rip saw, miter sawing, bevel sawing, and dado machine. The saw mandrel is placed on a carriage, and travels on ways. The saw is drawn toward the operator by the foot treadle, which allows the operator the use of both hands to handle the stuff. The mandrel is raised and lowered by means of rack and pinion to adjust the same and dado head to different thicknesses of work.

Saw Guide. An adjustable piece to direct the saw in cross cutting.

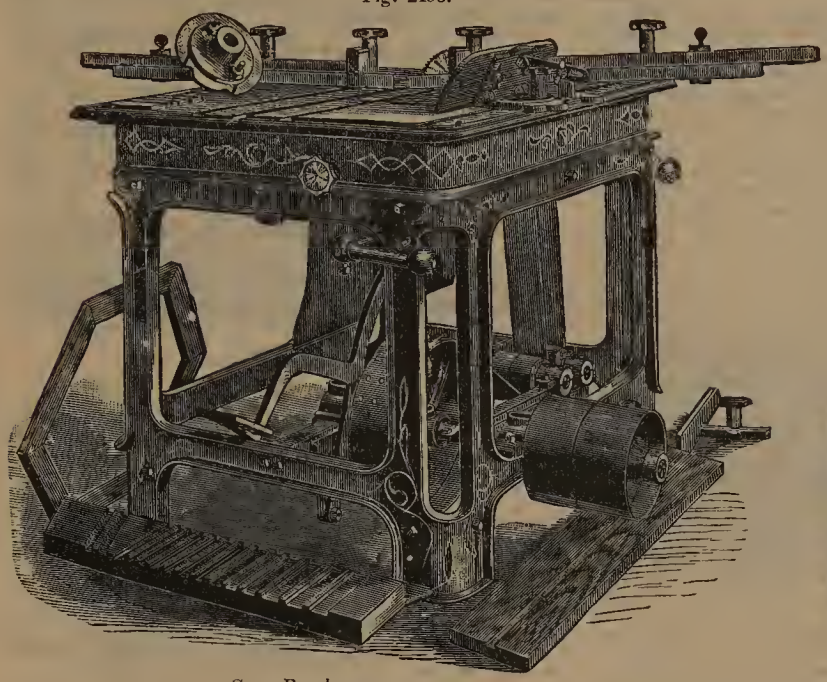
Saw'ing Ma-chine'. One with power-driven saw.

See under various heads in list of 160 kinds of saws, "*Mech. Dict.*," p. 2035.

Saw Joint'er. A device to enable gang saw operators to obtain and retain a correct, parallel, and uniform rake and breast line upon their saws.

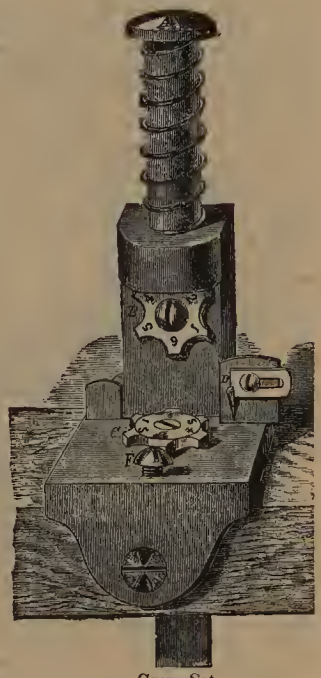
In Pond's saw jointer the saw is placed in a frame having

Fig. 2195.



Saw Bench.

Fig. 2196.



Saw Set.

tracks for the swaging blocks and file holder to travel on. The proper swage and knock-down is given each tooth by two blows on the double swaging blocks. The ways can be run up or down to preserve the breast line of the saws perfect when strained in the gate.

Experience has taught that no matter how carefully saws are strapped, and fitted by hand in the ordinary way, they will, when strained, vary on the rake line from one eighth to one half an inch in the stroke. One of the most important objects to be attained is the keeping of the saws jointed on just such lines as will give, when strained, a perfectly straight breast-line. After a saw is jointed and filed straight, put into the gate, keyed, and properly strained, it will often be found that the teeth are convex instead of being in a line as before the saw was strained. The back is slack. When the strain is forward of the center, that side will be taut, and present a convex edge, which increases or lessens in proportion to the width of the saw and the distance of the strain from the center line. The filer should give the saw a concave that will, when properly strained, become a straight line. To give a concave, so far, the eye alone has been depended upon without any scientific application of instruments. The concave should be made from end to end of the saw teeth, at every point the true arc of a circle. Unless all saws in the gang are jointed exactly alike and exactly right, the result of their action will be to retard the work of the gang, as the saws not properly jointed will wear out first and keep the good saws from performing the work they should do.

Saw Jump'er. A punch to shape the end of saw teeth. See SAW SWAGE.

Saw Set. An implement to spread the teeth of a saw laterally, to regulate the width of the kerf. See "*Mech. Dict.*," p. 2843, 2044.

In Fig. 2196 the plunger is operated by a treadle. The striking part and the anvil are star-shaped and similar in construction. The points are all of different sizes, designed to set different sized teeth.

Saw Ta'ble. A form of sawing machine adapted to trimming the edges of stereotype plates. See Fig. 5794, pp. 2079, "*Mech. Dict.*"

* "*Scientific American*" . . . . . xl. 340.

Saw Tem'per-ing. The process by which the saw is given the necessary hardness and elasticity. See TEMPERING, "*Mech. Dict.*," p. 2562.

When large saws are made red hot in tempering and then suddenly cooled, they are frequently bent and buckled. This is usually rectified by a skillful stretching of the rigid spots by hammer and anvil, which liberates the structure until, at length it is a flat surface, and runs true as a saw. In the new American system no hammering is resorted to. The buckled saw is compressed in a mold between two flat surfaces, the operation being performed in an oven made on purpose, which is carefully heated up to the proper temperature required to give the saw temper. The oven is allowed to cool down with equal care, and when taken out of the mold the saw is found tempered without being buckled. — *Dr. Anderson.*

Saw Tooth'ing Ma-chine'. One for increasing the depth of saw teeth. See "*Mech. Dict.*," 4616, 4617 *B*, 4636.

Saw Up-set'ter. A tool to turn over or display the teeth of a saw to widen the kerf. See SAW SWAGE.

Scab. (*Founding.*) A protuberance on a casting formed by the washing away of the mold-wall.

Scaf. (*Smithing.*) The tapered extremity or feather edge of a weld-lap.

Scaf'fold. In blast furnace practice, material which has been arched and refuses to melt down.

Scaf'fold-ing. See Elaborate illustrated article, *Laboulaye's* "*Dict. des Arts et Manufactures*," vol. iv., ed. 1877, article "*Échafaudage.*"

Scaffolding, Paris Exposition, 1878 . . . * "*Engineering*," xxviii. 108, 182.
Iron, *Hahn* . . . . * "*Scientific American Sup.*," 2701.
Screw (for chimneys).
Lish . . . . . * "*Scientific American*," xli. 134.

Scales. Devices for obtaining the dimensions or weights of bodies. See "*Mech. Dict.*," pp. 2048–2051, and *supra*, pp. 316, 414, 415.

The American, French (metric), Charriere, and English gages of urethral instruments are given on pp. 5, 6, Part III., *Tiemann's* "*Armamentarium Chirurgicum.*"

The Fairbanks was the original compound lever weighing scale, though most American scales are of this class.

The principle of the platform scales consists in supporting a platform upon a system of four horizontal levers, which are placed in a shallow portable box or in a pit in the ground. These levers are iron bars set on edge, and each hanging upon a fixed knife edge of steel in one of the corners of the box or pit. On the original plan they all met under the center of the platform, their ends resting on the short arm of a fifth lever also of the second order, the long arm of which extended beyond the margin of the platform and was suspended by means of a connecting rod to the short arm of a lever or index beam at a convenient height above the ground. This in all the scales receives the counterpoise and the

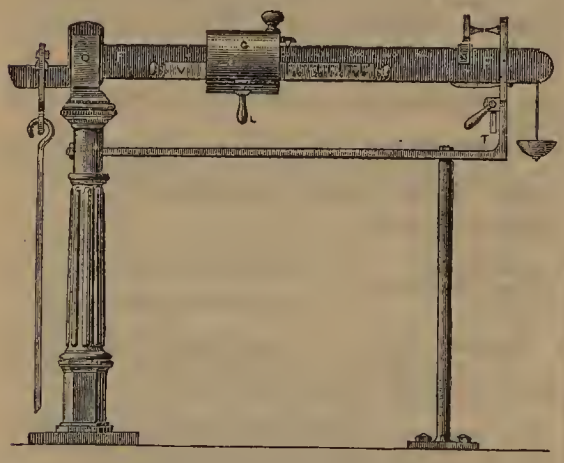
weights. The platform was fitted to a hox or to a recess around the edge of the pit, resting there when not in nse. Near each corner a foot projected dowuward terminatiug in a steel plate, and as the levers were raised a very little by the depression of the index beam, a knife edge fixed to each of them near the fulcrnm reached this plate and together lifted the platform and its load. The weight, it is seen, was thus divided betweeu the four levers resting npon them between their fulcrums and the power, aud several times nearer to the former than to the latter. Such proportion of the load was therefore borne by the four corners, relieving the scale beam of this, as the length of the long arm of one of the levers to its whole leugth. The scale beam was still further relieved by the fifth lever, which was of the same order as the others, aud received the weight a little within its fulcrum, which also worked upon a knife edge. In the scales of more recent coustruction the fifth lever is done away with, and two from the corners and at one end of the box or pit are extended entirely across, meeting each other beyond the opposite end and directly under the scale beam, with which they connect. The other two levers meet the first pair and connect, one with each of them, jnst midway across. A steel ring at this point hangs upon a knife edge of each of the levers of the first pair, and into this is introdnced the knife edge, facing downward, of one of the other levers.

The adjustment of the bearing points is made with the utmost precision, so that the results do not vary if the load is placed successively upon different portions of the platform. Considering the small proportion of the load that actually comes upon the seale beam to be weighed, in the largest machines sometimes amounting to not more than the one hundredth or even the one-thousandth part, the resnlts are surprisingly accurate. At a test made in the Crystal Palace, New York, 52,600 pounds was weighed successively on every portion of the platform of a railroad track scale, and the greatest variation froun the main weight was three pounds.

The gradnation of the beam is made very exact by machine work, and all the corresponding parts in the scale.

Chamoroy's (Paris) invention is a weighing machine, made to register the weight ascertained, by printing it on tickets during the operation of weighing. This is accomplished by arrauging at suitable distances aloug the edge of the scale beam a series of punches, like those for stamping names or figures on wood or iron, with projecting figures: in a machine for weighing up to a thousand kilograms — about a ton — these figures represent hundreds. A movable plate is inserted iu the sliding weight below the beam, and capable of being brought into contact with it by a lever. The ticket is introduced between the plate aud the under edge of the beam through an aperture iu the sliding weight. These figures priut the hundreds; but the tens figures following by a liue are set on the under side of a short bar which works iu the sliding weight like the bolt of a door. The tickets

Fig. 2197.



Chameray's Registering Scale.

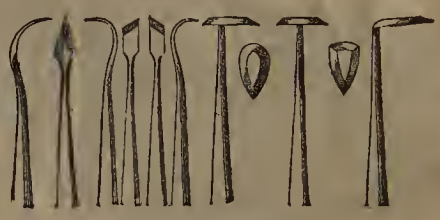
having been alreadv printed with equi-distant spaces numbered to represent the units and divided by dots, wheu an article has to be weighed, the sliding weight is brought under whichever hundreds figure corresponds to the nearest approximation to the weight, and equilibrium is obtained by moving the short bar, previously mentioned, from left to right in the sliding weight. The ticket is then inserted between the movable plate and the beam, and a smart blow on the lever punches the tens and hundreds figures on the tickets, the position of the horizontal line following the tens figure with respect to the dot and line already printed, permitting of the weight being ascertained and printed correctly to a quarter of a kilogram — ¼ lb.

Scale, *Marquoi* . . . * "*Scientific American Sup.*," 2095.
Scale-beam, compound division, *Weeks* . . * "*Iron Age*," xxiii., May 8, p. 24.
Scale board mach., *Huey* * "*Scientific American*," xlii. 276.
Scale equilib., *Redier*, Fr. "*Manufact. & Builder*," x. 205.
Scale factory, *Fairbanks* * "*Scientific American*," xliii. 287.
Scales, automatic, *Stoner* * "*Scientific American*," xliii. 371.
Weighing, *Riehlę* . . * "*Scientific American Sup.*," 498.
Platform scale, constant equilibrium, *Redier*, Fr. * "*Scientific American*," xxxix. 233.
Fig. 976, p. 316, *supra.*

Sca'ler. A dentist's tool for removing scale or tartar from teeth.

Especially shaped and designed for removing deposits of salivary calculus from the uecks and interspaces of the teeth.

Fig. 2198.



Dentist's Scalers.

Sca'ling Knife. (*Fishing.*) A knife for removing scales; sometimes has a saw edge.

Scalp'ing. (*Milling.*) Brushing the *hair* or fuzz from the ends of wheat grain to prevent its getting into the flour. One of the refinements of the new wheat processes.

Scan'di-na'vi-an Belt'ing. Cotton cloth woven solid and treated with Stockholm tar. Paper by Cobbett, London Association of Society of Foreman Engineers, reported in "*Scientific American Sup.*," 3800.

Scan'di-na'vi-an Lock. A form of lock for securing hasps to staples. It is made heavy, both branches of the bow withdrawing from the lock. See Jail Lock, Fig. 1481, p. 511, *supra.*

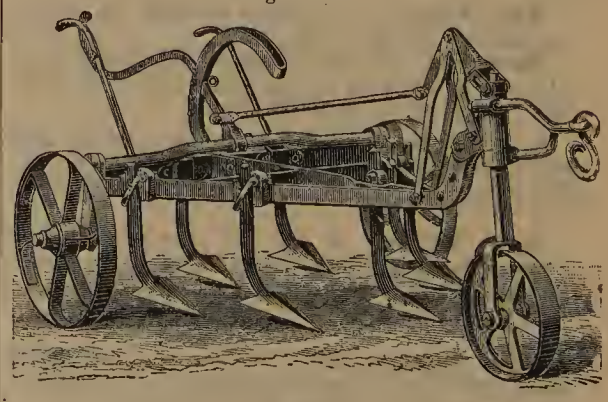
Scar. (*Founding.*) A weak or faulty part in a casting, due to an imperfection of the metal.

Scarf'ing Frame. A holder in which a band-saw is placed while the scarfed ends are brazed together. See Band-saw Holder, p. 72, and Fig. 199, p. 73, *supra.*

Scar'i-fi-er. A cultivator having long, sharp teeth, with wheels to regulate the depth of cut.

Fig. 2199 is a French horse-power cultivator of the largest class; it is called a *Scarificateur extirpateur*, and is an effi-

Fig. 2199.



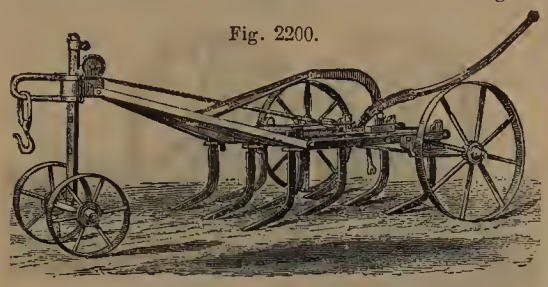
French Scarifier. (*Breloux, Nevers, France.*)

cient implement when sufficient power is applied. Seven shares are fixed in the triangular iron frame, the front angle of which has a goose-neck in which the standard of the caster wheel is placed. A siugle movement of the lever raises or

depresses the frame at all points equally, so as to keep it in parallelism with the soil. It resembles some of the cultivators in the series of steam-plow implements.

Fig. 2200 is much like the preceding, but having four

Fig. 2200.

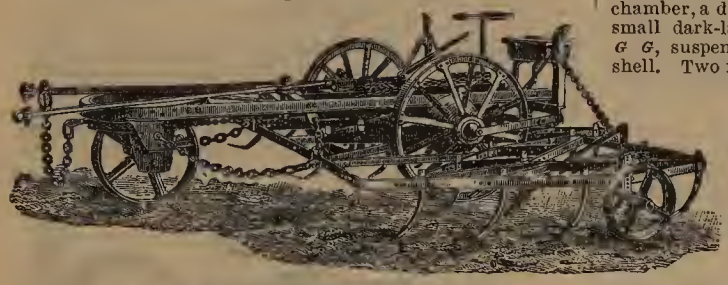


Four-Wheeled Scarifier.

wheels instead of three, and teeth more for stirring than cutting.

Fig. 2201 shows a turning harrow, between a steam cultivator and steam harrow. It is fitted at will for either of two kinds of shares, a broad one for cutting and a square-pointed one for simply stirring the ground. The instrument is in three pieces to accommodate itself to uneven surfaces, and will take in a breadth of 12′ to 15′. The steering frame is adapted to take different harrows, from the lightest seed-harrow up to cultivating tools. On the short end of the turning lever is a chain communicating with a quadrant on the crank axle, and as the lever is pulled around the chain, acting on the quadrant, turns the axle, lifts the frame, and raises the tines out of the ground.

Fig. 2201.



French Cutting and Stirring Scarifier.

Sci-en-tif'ic Ap'pa-ra'tus.

Scientific apparatus, London exhibition of	"*Engineering*," xxi., various art.
Loan collect. Engl.	"*Scientific American Sup.*," 505.
London exhibition of	"*Engineering*," xxii. 4 and following.
Exhibition of	"*Engineer*," xli. 341, 352, 371, 376, 389, 425, 481-486.
Scientific logs	* "*Man. & Builder*," viii. 36, 60.

Scis'sors. (*Surgical.*) The following list of shears and scissors used in surgery embraces the more important: —

Amputating cervix.	Perforating.
Angular.	Pile.
Artery.	Phymosis.
Canulated.	Plaster of Paris.
Ceratome.	Probe-pointed.
Conjunctiva.	Pterygium.
Curved.	Staphylorraphy.
Dissecting.	Strabismus.
Dressing.	Tonsil.
Ear.	Tonsilotome.
Enterotome.	Tooth-edged.
Harelip.	Trachea.
Hemorrhoidal.	Uterine.
Hysterotome.	Uvula.
Iris.	Wire-cutting.

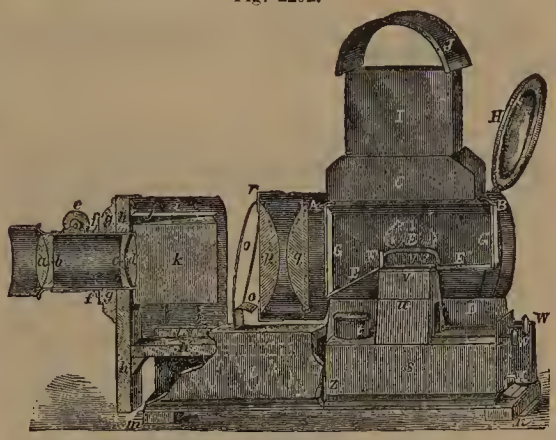
See many illustrations in Fig. 4671, p. 2054, "*Mech. Dict.*" Some others are shown in present volume under their alphabetical heads. See also: —

Bankers' scissors.	Paper-hangers' shears.
Barbers' scissors.	Pocket scissors.
Button-hole cutters.	Pruning shears.
Ladies' scissors.	Sardine shears.
Nail scissors.	Tailors' shears.
Paper scissors.	Trimmers, straight and bent.

Scissors, for glass.

Martini	"*Technologiste*," xxxviii. 217.
Bruder-Johnson	* "*Iron Age*," xvii., Jan. 13, p. 9.
Young	* "*Iron Age*," xvii., Feb. 3, p. 11.
Folding	"*Scientific American*," xxxv. 159.
Scissors gage, *Wiggins*	* "*Scientific American*," xxxv. 66.

Fig. 2202.



Marcy's Oil-light Sciopticon.

Sci-op'ti-con. A form of magic-lantern for exhibiting photographic objects.

Fig. 2202 shows Marcy's Oil-light Sciopticon. The flame-chamber, a distinctive feature of the oil-light sciopticon, is a small dark-lantern in itself, with a front and back-glass, *G G*, suspended by cross-strips in a ventilated protecting shell. Two flames, starting wide apart at *v v*, are deflected as close toward each other as they can be without interfering, over a rising current of air, which thoroughly oxygenates the inner surfaces. The chimney-cap is telescoping, and can be raised or lowered. The reflector *H* is outside the flame-chamber, and answers the purpose of door and reflector. Its burnished surface is kept from tarnishing by a protecting film. The condenser *p q* is suspended free from contact in a chamber separate from the flame-chamber. Its front band presents a good bearing for rests and slides, and the lenses are removable. The exteusiou front is readily removable to give access to the interior of the instrument, and can be drawn forward to suit different lenses.

Schist Oil. Article "*Huile de Schiste*," Laboulaye's "*Dictionnaire des Arts et Manufactures*," tome iv., ed. 1877.

Scoop. 1. (*Surgical.*) A ladle or spoon shaped instrument used in removing objects from cavities. Among them are those having the following applications: —

Bone.	Laryngeal.	Sessile tumor.
Cataract.	Lithotomy.	Urethral.
Leus.	Rectal.	Uterine, etc.

Thomas's serrated scoop for the detachment of sessile uterine fibroids has a saw-shaped edge to the scoop.

See also CURETTE.

2. A form of wheel used in lifting water. See Fig. 4677, p. 2055, "*Mech. Dict.*"

3. A spoon-shaped capacious shovel.

4. A bowl-shaped pan on a weighing-scale.

Weighing scoop	* "*Scientific American*," xxxviii. 23.
Scoop, smooth back. *Hussey, Burns & Co.*	* "*Iron Age*," xix., April 5, p. 11.

Scoop Net. (*Fishing.*) A baling net for emptying the fish collected in a pound.

Scor'ing Ma-chine'. The corner cutting and scoring machine is one used in making small boxes of card-board, to cut off the superfluous material from the blank and to make a score on the future angles of the box in order to make the stuff bend readily and accurately at such places.

See PAPER-BOX SCORING AND CUTTING MACHINE.

Score. (*Nautical.*) The groove on the body of a tackle-block to hold the strap.

Scour'er. A form of grain cleaner in which the berry is subjected to a rubbing action to remove all extraneous matters: smut, dust, mildew. See GRAIN CLEANER, SMUTTER, etc., and references *passim.*

Scour'ing. 1. (*Grain.*) A process in which grain is rubbed and brushed to remove smut, dust, mildew, etc.

2. (*Leather.*)

Scouring on the flesh. — On being taken out of the water the skins are spread out and set on the scouring table by passing a steel slicker over the flesh side, which brings the grain in close contact with the table, and, being wet, it adheres to it. A bountiful supply of water is applied and rubbed briskly over the flesh side with a stiff brush, whereby the pulpy portions of the surface are scrubbed off, and the skin presents a soft, whitened appearance and the pores are opened.

Scouring on the grain. — The skin is set on a scouring table by a slicker, which stretches it and at the same time loosens the bloom. The grain side is kept uppermost, and is smartly brushed with a stiff hair brush, using at the same time plenty of water, when the slicker is again used to remove the water and loosened bloom. A stock-stone is often used instead of the slicker to loosen the bloom.

3. (*Fabric.*) A process for renewing the surface of soiled stuffs, removing stains, etc. The dégraissage of the French. *Laboulaye's "Dictionnaire,"* i., *"Degraisseur."*

Scour'ing Ta'ble. (*Leather.*) A large firmly built table, with a mahogany, bird's-eye maple, slate, or marble top. It is about 12′ long and 4′ wide, so constructed that the water used in scouring may pass off readily upon the side opposite to that on which the workman is engaged.

Scow, Cheap. A small flat boat.

Scow, cheap . . . * *"Scientific American Sup.,"* 397, 410.

Scrap Cut'ting Ma-chine'. A machine for cutting long metal scrap for bundling and reworking. See BAR CUTTER.

Scrap shears.
Parkjute Iron Works, Br. . * *"Engineering,"* xxix. 284.

Scra'per. (*Iron Working.*) 1. A tool used in getting a true face on a metallic surface after leaving the planer.

2. An arrangement for leveling or moving dirt, removing weeds, etc.

A leveling attachment for dirt cars. Two spreading wings attached to the rear car of a construction train run outside the rails near the ties, to level the dirt that has been dumped from the preceding cars.

The Johnson wheeled earth scraper, Fig. 2203, is suspended from the axle by a hanger pivoted at the lower end in the center of the side of the scraper box. The axle being free at the top permits the wheels to roll forward when raising the back end to fill or dump, although the formation of the scraper will not admit of a horizontal position while filling.

Earth car, Leveling attachment for.
Andrews . . . . . * *"Scientific American,"* xliii. 271.
Scraper, Earth . . . . * *"Scientific American Sup.,"* 225.

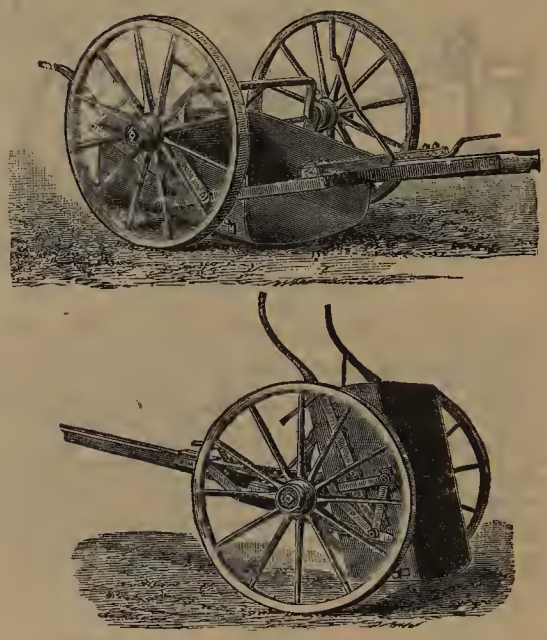
Pettier's scraper for cleaning in gardens and vineyards has a broad hoe-shaped blade, followed by a row of iron teeth. The blade cuts the weeds and grass off at the surface of the ground while the teeth gather up the grass and weeds, and loosen the soil.

For different scrapers, see pp. 2057-2059, *"Mech. Dict."*
Wheeled, Fig. 4694, p. 2058, *"Mech. Dict."*
Revolving, Fig. 4695, p. 2058, *Ibid.*
Oblique board, Fig. 4693 *B*, p. 2058; Fig. 4365, p. 1954, *Ibid.*
Wagon mounted, Fig. 4696, p. 2059, *Ibid.*
Scraper, earth, *Doty* . * *"Engineer,"* xlii. 199.
Revolving, *Revolving Scraper Co.* . . . * *"Iron Age,"* xvii., Feb. 17, p. 19.

(*Wood Working.*) Fig. 2204 shows Whitney's machine for giving a fine surface to hard woods, particularly where the grain is irregular; a planing machine, in which the wood is carried by rolls suitably placed against a stationary cutter.

This cutter is a steel blade of sufficient length to extend across the machine, secured in a block of such strength as to be safe against springing. This blade is exceedingly sharp,

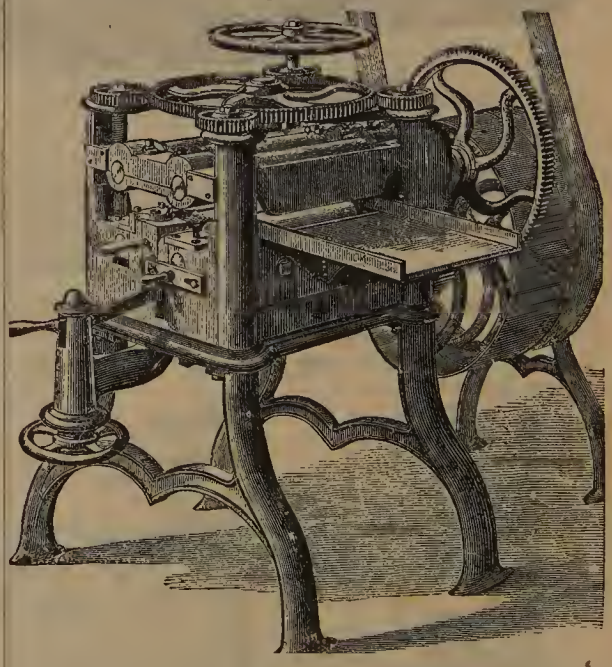
Fig. 2203.



Earth Scraper.

and has the feather-edge which is generally considered essential in a scraping-tool for wood. The blade is very carefully set to take the thinnest possible shaving from the surface of the wood, which is given an ordinary good finish on the planing machine before it is sent to the scraper. A little machine accompanies the scraper, specially designed to sharpen the

Fig. 2204.



Wood Scraper.

blade. It consists of a pair of emery-wheels, so set that one can bevel the edge of the cutter while the other squares up the face. The blade is clamped, during the operation, between a pair of jaws, which hold it firmly and precisely in position. As the sharpened blade passes from under these wheels, a stationary steel bar touches the edge, and, sliding along it, turns it, producing the feather-edge.

Scrap'ping. A device for carrying away the scraps of paste, the residuum of the sheet after

stamping out crackers, biscuits, or cakes in the machine. See CRACKER-CUTTING MACHINE; PANNING MACHINE.

Scratch'er. (*Plasterers.*) The scratcher is made of pointed slats, set 1″ apart, and kept in position by cross pieces; one slat is left longer than the others, and answers the purpose of a handle.

Screen. A separator or partition.

A screen for working ores by the wet process is made of Russian sheet-iron, the smooth planished iron being punctured with fine holes.

Screens for working dry ores are made of wire, and vary in fineness from 900 to 10,000 meshes to the square inch.

A protecting shield around radiators.

A sifting arrangement for sand, etc.

A blind to intercept heat or light.

A riddle or sieve. See GRAIN CLEANER, etc.

A jigger, etc., for ore.

See "*Mech. Dict.*," p. 2059.

Screw. See under the following heads: —

Cap screw.	Oval point set screw.
Coach screw.	Round head cap screw.
Countersunk head screw.	Screw bolt.
Hanger screw.	Screw eye.
Hexagon-head cap screw.	Screw knob.
Knob screw.	Set screw.
Lag screw.	Skein screw.
Machine screw.	Wood screw.

Screw-head key . . . * "*Eng. & Min. Jour.*," xxvi. 187.
Screw-plate . . . . . * "*Iron Age*," xxii., Dec. 5, p. 9.
Launch engine . . . Figs. 1549–1555, pp. 531, 532, *supra.*
Screw cylinder engine . *Infra.*
Six cylinder engine . . *Infra.*
Screw propeller, feathering, *Moyse*, Br. . . . * "*Engineer*," xlv. 59.
* "*Scientific American Sup.*," 2299.
Screw steerer . . . . * "*Scientific American Sup.*," 2162.

See article "*Helice*," *Laboulaye's* "*Dictionnaire des Arts et Manufact.*," tome iv., ed. 1877. Number of arms; diameter; area; rate and recoil, etc. Sollier's and Mangin's systems.

Screw-thread forging machine . . . . . * "*Scientific Amer.*," xxxvii. 114.
Screw propeller.
Deane, Br. . . . . * "*Engineering*," xxviii. 40.
De Bay . . . . . * "*Scientific American*," xliii. 193.
De Bay, yacht "Iolar," Br. . . . . * "*Engineer*," xlviii. 352.
Eyre . . . . . * "*Engineering*," xxiii. 236.
Eyre, Engl. . . . . * "*Scientific American Sup.*," 1169.
Griffiths . . . . . "*Scientific American Sup.*," 2873.
Ressel (1812), Sweden * "*Engineering*," xxvii. 13.
S. S. "City of San Francisco," *Roach* . . * "*Engineering*," xxiii. 268.
Thorneycroft . . . * "*Scientific American Sup.*," 1220.
Thorneycroft, Br. . . * "*Engineering*," xxi. 88.
Assistant.
Mackenzie, Br. . . * "*Engineer*," xlviii. 198.
Dynamometer.
Froude, Br. . . . * "*Engineer*," xliv. 77.
Feathering.
Kirk & Hunt, Br. . * "*Engineering*," xxix. 225.
Moysey, Br. . . . . * "*Engineer*," xlv. 59.
Raising, etc., *Sadlier* . * "*Scientific Amer.*," xxxviii. 120.
Testing apparatus . . * "*Engineer*," xlvii. 389.
Testing apparatus, Br. * "*Engineer*," xlvii. 124.
Screw propellers.
Howden . . . . . * "*Scientific American Sup.*," 1599.
Screw cutting machanism.
Engl. . . . . * "*Scientific American Sup.*," 2463.
Screw cutting tools, kit of, *Wiley & Russell* . * "*Scientific American*," xxxvi. 54.
Screw cutter and nut tapper, *Schlenker* . . * "*Iron Age*," xxi., May 2, p. 26.
Screw collier "Fenton," *Austin & Hunter*, Br. * "*Engineering*," xxviii. 490.
Screw cutting lathe . . * "*Scientific American*," xxxvi. 118.
Brown & Sharpe . . * "*Man. & Builder*," xi. 199.
Ferris & Miles . . . * "*Engineering*," xxi. 372.
* "*Railroad Gazette*," xxi. 71.
Goodnow . . . . . * "*Scientific American*," xxxix. 53.
Johnson . . . . . * "*Iron Age*," xix., March 8, p. 5.
Weise . . . . . * "*Scientific American*," xxxv. 291.
Screw cutting foot lathe.
Astbury, Br. . . . . * "*Engineering*," xxx. 321.
Screw driver, *Abrams* . * "*Scientific American*," xli. 358.

Screw engine (for propellers) *Cramp* . . . . * "*Engineering*," xxi. 480.
Screw hoisting tackle.
Box & Co. . . . . * "*Iron Age*," xxiii., Feb. 13, p. 11.
Screwing machine.
Pratt & Whitney . . * "*Engineer*," xlii. 24.
Barrow, Br. . . . . * "*Engineering*," xxx. 127.
With releasing motion.
Brown, Br. . . . * "*Engineer*," xlii. 349.
Screwing and tapping machine, *Pratt & Whitney* * "*Engineering*," xxi. 248.
Bowker . . . . . * "*Scientific American Sup.*," 165.
Screw-jack, 6-ton.
Maude, Br. . . . . * "*Engineer*," xlvii. 117.
Telescopic, *Ball* . . * "*Engineer*," xlix. 286.
Screw machine.
Browne & Sharpe . . * *Thurston's* "*Vienna Rept.*," ii. 232.
Pratt & Whitney . . * *Thurston's* "*Vienna Rept.*," ii. 225.
Self-slotting, *Hubbel* . * "*Iron Age*," xviii., Nov. 30, p. 1.
Screw shaft flexible coupling, *Snowden*, Br. . * "*Engineering*," xxix. 474.
Screw shafts, flexible coupling for . . . . * "*Scientific American Sup.*," 3898.
Screw steamer of 1804.
Stevens . . . . . * "*Manufact. & Builder*," ix. 190.
Screw thread forging machine, *Bouchacourt & Delille*, Fr. . . . . * "*Engineer*," xliii. 417.
Screw ventilator, *Pelzer* * "*Scientific American Sup.*," 4071.

Screw Burn'er. (*Lamps.*) *a.* A burner in which the wick is lifted and depressed by a screw. Found in Argand lamps.

b. A burner which fastens by screw thread to the socket of the lamp-top.

Screw Cal'i-pers. In which the adjustment of the points is made by screw. See several forms in Fig. 1029, p. 429, "*Mech. Dict.*"

Screw Cut'ting Ma-chine'. A screw cutting machine takes a rod of iron, steel, or brass, and by an automatic series of operations drops screws at the other end of the machine. One tool cuts the point of the rod down to the dimensions of the screw, another cuts it off, having the head the full size of the rod, another takes it from the last and passes it on to have the thread cut, a cutter passes by and leaves it slotted, another with four iron fingers takes it and transfers it to a fifth cutter, where the head is finished, when still another tool comes to push it into the pan placed to receive it. No intervention is needed until another rod is wanted. See SCREW, *supra.*

Fig. 2206 represents a machine for screwing and cutting off steam and gas pipe. The belting and gearing are arranged for obtaining suitable power and speed for the varying sizes of pipes. The die and head to which it is attached are so constructed that pipe may be alternately screwed and cut off without removing the die from the machine.

See various forms on pp. 2065–2067, "*Mech. Dict.*"

A form of lathe as in Figs. 4725, 4734, pages above cited.

See also BOLT-CUTTER, Figs. 367–371, pp. 117, *supra*; Figs. 770, 771, 777, 778, pp. 324–326, "*Mech. Dict.*"

TURRET LATHE, Fig. 6824, p. 2665, "*Mech. Dict.*"

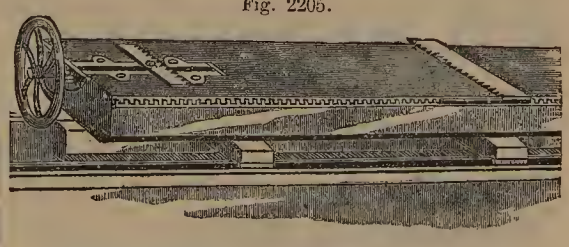
PIPE THREADER, Fig. 3744, p. 1712, "*Mech. Dict.*"

SCREW, *supra.*

Screw Ma-chine'. In sheet-metal working, a machine for threading zinc or sheet-metal screws for can-tops, etc.

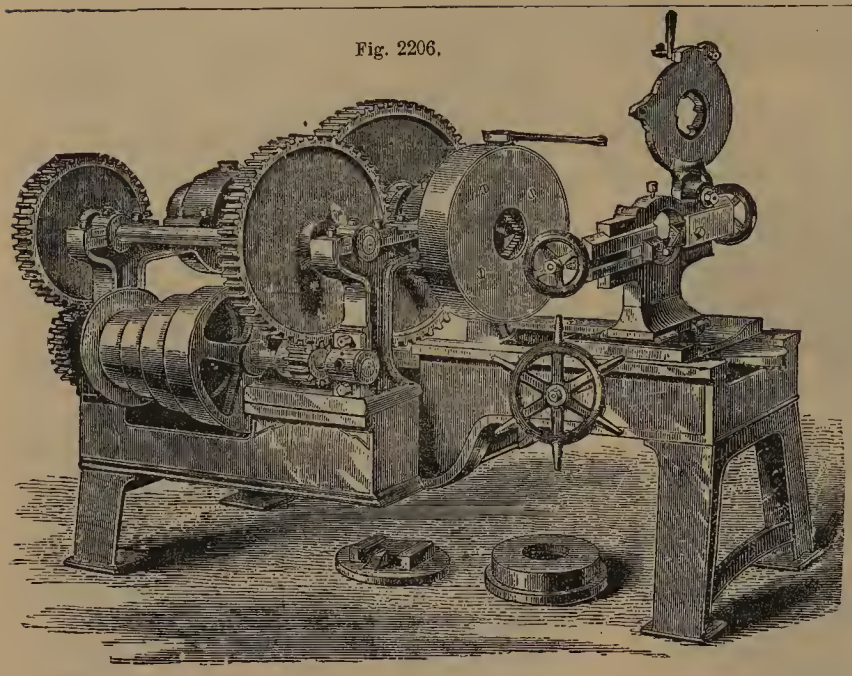
Screw Dog. A clamp to hold the stuff firmly in the carriage, adjustable by a screw.

Fig. 2205.



Extra Screw Dog for Holding Dimension Stuff.

Fig. 2206.



Screw Cutting Machine.

Fig. 2205 shows a feeding or tail screw hung in an iron box, let into the back end of the carriage, so as to come entirely below its surface; on this screw is a nut with a traverse dog for holding the stuff, and operated by a hand-wheel on the outer end of the screw. The front dog for holding the stuff consists of a plate having teeth on one side and running across the entire width of the carriage and which is held in its place by teeth on an iron plate let into the sides of the carriage, requiring no bolts or keys to hold it firm.

Screw El'e-va'tor. 1. (*Dental.*) A staff with gimlet screw on the end to screw into a root as a means of withdrawal. Fig. 4730, p. 2066, "*Mech. Dict.*"

2. (*Surgical.*) A hard rubber conical screw to force open the jaws of maniacs or lock-jawed.

3. A form of passenger lift in which a screw is used to elevate the cage.

Screw En'gine. Engines of this type, for vessels up to 300 tons, have inverted steam cylinders carried on strong hollow standards, which also form the guides for the cross-heads. The slide valves are between the cylinders, and the valve-box cover is on the side, giving easy access to the valves for examination. The engines have case-hardened link-motion reversing gear, and separate expansion valve.

The condenser is fixed on one side; the air-pump is driven by side levers from the cross-head of the engine. The standards which carry the engines are fixed to a strong cast-iron base-plate; the bearings for the crank-shaft, including the thrust bearing, are also secured to this plate. The screw shaft is coupled direct to the crank-shaft, and passes through a stern tube, as shown. It is usually fitted with a three-bladed screw propeller, but any other form may be adopted, and the propeller is made of malleable cast-iron, gun-metal, or cast-steel, as may be desired, the price varying according to the material employed. The boiler is of the ordinary circular form, with an internal flue and return tubes, the uptake leading to the chimney being in front of the boiler and directly above the fire-door. The boiler is of the best material and workmanship throughout, and is furnished with all the steam mountings and furnace fittings necessary for its safe, efficient, and economical working. A donkey-pump feeds the boiler.

M. Cavé's (Fr.), *Fig. 3417, vol. iv., Laboulaye's "*Dict. des Arts et Manuf.*," ed. 1877, article "*Bateau à Vapeur.*"

Screw Eye. A loop with threaded shank, to be screwed into an object.

Screw Fin'ish-ing Ma-chine'.

Fig. 2207 is specially adapted for small hand-tooling, finishing the heads of screws, pins, and a variety of similar work. A half-inch hole extends through the spindle. Self-adjusting shell chucks are used in the spindle. These are opened by the knee of the operator without stopping the machine, thus saving the time of stopping and starting every time the work is put into the machine or removed. The boxes are self-oiling, running from two to three months without the necessity of oiling them. The machine is arranged for a high rate of speed. Tight and loose pulleys are upon the spindle Either one or two counter-shafts accompany the machine, as may be desired. They are provided with adjustable hangers, iron cones, and pulleys. First countershaft should run 450 turns per minute. Tight and loose pulleys 6″ diameter, 2½″ face. Weight of machine with both countershafts, 425 lbs.

Screw for Boot Soles. Article "*Chaussures à Vis,*" *Laboulaye's "*Dict. des Arts et Manufactures,*" vol. iv., ed. 1877. See Sole-screwing Machine.

Screw Gage. 1. A device for measuring the pitch of the threads of the screw.

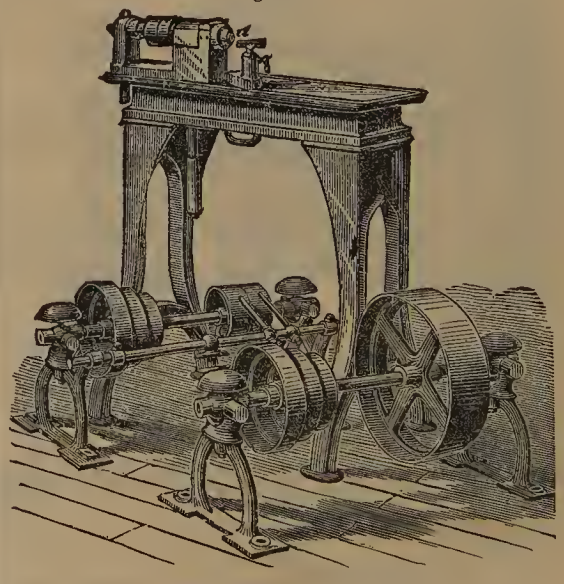
2. For indicating the diameter.

See Screw Thread Gage, Fig. 4755, p. 2074, "*Mech. Dict.*," and Wire Gage, Fig. 7281, p. 2793, *Ibid.*

A steel ring with internal screw of standard size and proportions, used for measurement and for testing accuracy of screws.

See External and Internal Gages.

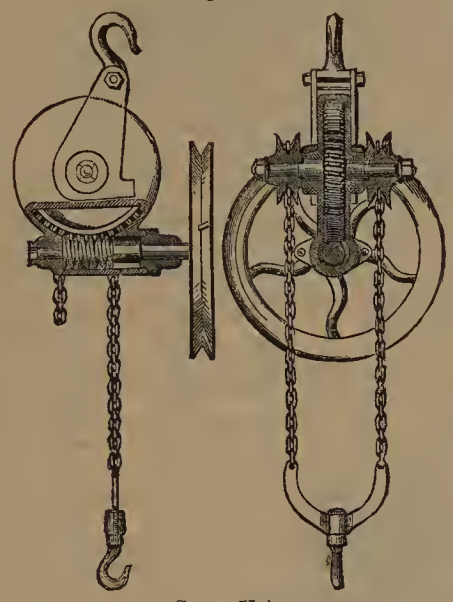
Fig. 2207.



Screw Finishing Machine.

Screw Hoist. In Fig. 2208 the axle of the ordinary large winding wheel has screw threads cut thereon which mesh with the gear on a smaller wheel set above the axle and transversely to the large wheel. On the opposite ends of the axis of the latter wheel are pulleys, over which chains pass which are attached to the swivel hooks below. It will sustain at any point, but will lower rapidly when started.

Fig. 2208.



Screw Hoist.

Screw Hook and Eye Hinge. A hook and eye gate hinge, each part of which has a screw shank.

Screw Hook and Strap Hinge. A hook and eye hinge of which the hook part has a screw shank and the eye part a strap to be secured to the gate or door.

Screw'ing Stock. A stock or handle which holds the threaded nut for making a thread on a bolt or bar. A screw plate.

Fig. 4739. *f*, page 2069, "*Mech. Dict.*"
Fig. 4754, *a*, p. 2074, *Ibid.*

Screw Knob. A curtain knob with screw shank.

Screw Line Box. One the cover of which is depressed by a screw. A *spring* line box is shown in Fig. 1615, p. 552, *supra.*

Screw Ma'king Tools. Taps, dies, stocks, etc. Figs. 4739, 4754, pp. 2069, 2074, "*Mech. Dict.*"

Screw Nick'ing Ma-chine'. One for cutting the nicks in screw-heads. See SCREW SLOTTING MACHINE.

Screw Pile. (*Hydraulic Engineering.*) The procedure in the setting of the screw-piles for the United States pier near Lewes, Del. (1877, 1878), is carefully shown in the "*Report of Chief of Engineers U. S. Army,*" 1879, * i. 448.

Mitchell, * *Laboulaye's* "*Dictionnaire,*" iv., ed. 1877; "*Pilotis.*"

Screw Pol'ish-ing Ma-chine'. See SCREW FINISHING MACHINE.

Screw Press. A machine in which the pressure is given by means of a screw. The applications are numerous and the examples are given under specific heads. See list under PRESS, *supra*, and p. 1784, "*Mech. Dict.*"

Some of the prominent are under
CHEESE PRESS, Fig. 609, p. 194, *supra.*
CIDER PRESS, Figs. 616-618, p. 196, *supra.*
OLIVE PRESS, Figs. 1839-1841, p. 642, *supra.*
PORTABLE PRESS.
STEARINE PRESS.

Screw Sha'ving Ma-chine'. A machine for turning off wood-screw blanks.

It is furnished with ten spring collets, a cross-rest with two shaving tools, oil-tank, dripper, and countershaft. The collets are opened and closed in the spindle by a hand-lever, and hold screws ¼″ to ⅝″ diameter, increasing by sixteenths; ⅝″ to 1″ diameter by eighths. The shaving tools are circular, and may be sharpened by grinding without changing their form.

Screw Slot'ting Ma-chine'. The device shown in Fig. 2209 can be attached to an ordinary hand lathe, and is believed to be more efficient for the purpose than any machine heretofore made. An active boy can slot from ten to fifteen thousand screws per day.

Fig. 2209.

Screw Slotting Machine.

A single bolt fastens the platform *A* of this apparatus to the bed of a hand lathe, the long lever projecting in front at a right angle with the bed. An arbor carrying a circular cutter is held in the center of the lathe. The long lever is moved horizontally to open the jaws for inserting and removing the screws, and downward to bring the screws to be slotted against the saw. The stop screw *B* governs its downward motion, and thus regulates the depth of slot in the screw head. The working part of the apparatus can be raised or lowered on the platform front by means of the bolt *C*.

In the Pratt & Whitney machine, the head-stock has a cone of 3 grades for a 2″ belt. The stock holding the vise-jaws and dies may be adjusted toward or from the spindle and transversely across the table. The spindle carries a rotary cutter, against which the head of the screw is brought by a vertical movement of the vise, produced by a hand-lever, rack, and pinion. The same motion of the lever that closes the vise, also raises it with the screw to be slotted, and a weight under the table instantly opens the vise and releases the screw as soon as the pressure on the hand-lever is removed. The machine slots screws of 9-16″ and less diameter. Weight of machine, with countershaft, 500 pounds.

Screw So'ling Ma-chine'. A machine for uniting the uppers and soles of boots and shoes by means of a brass screw made on the machine, operating automatically, whereby it grasps the wire, carries it forward, cuts a thread upon it, screws it into the sole of the shoe and cuts it off in suitable lengths — all at the same time. — *Tyson.*

Screw Steer'er. A device to assist the helmsman in holding the rudder at every point of its movement, to prevent the rudder kicking or running down by surges.

See STEERING APPARATUS, Figs. 5757-5760, p. 2372, "*Mech. Dict.*," and Fig. 4753, p. 2073, *Ibid.*

Scri'ber. A marker.

Scribing tools, *Rose* * "*Engineering,*" xxi. 119, 139, 330, 521.

Scrod'dled Ware. (*Ceramics.*) Ceramic ware, made by taking scraps and pieces of differently colored clays, such as are left over in making vases and plaques, and laying them together, joined but not intermixed, so as to produce a marbled or mottled effect.

Tortoise-shell ware had a similar origin. See also PÂTE CHANGEANTE.

Scroll Chuck. A lathe chuck in which the dogs are moved in concert by a scroll hidden in the body of the chuck; as in Fig. 4767, p. 2077, "*Mech. Dict.*" Several of the chucks shown in Figs. 874-876, pp. 273-275, and Figs. 1540-1544, p. 529, *supra*, are scroll chucks.

Scroll Lathe. One adapted to turn spiral and scroll work, such as balusters, table and piano legs, etc. See Fig. 555, p. 174, *supra.*

Scro'tal Clamp. (*Surgical.*) A clamp for castrating or for amputation of redundant scrotum for the relief of varicocele Scrotal forceps.

Scro'tal Com-pres'sor. (*Surgical.*) For mechanical pressure on the morbidly distended

scrotum in orchitis. A hard rubber globular bag with lacing holes.

Scro'tal In'stru-ments. (*Surgical.*) Instrument for hydrocele, varicocele, etc. The list includes: —

Canula.	Scrotal clamp.
Depilating forceps.	Suspensory bandage.
Injector.	Scrotal compressor.
Varicocele clamp.	Trocar.

Scrub'ber. A washing and brushing, cleansing apparatus.

Scrubber gas, on.
Hunt, Br. . . . . "*Engineering*," xxii. 43.
Scrubbing machine, domestic, *Stockley* . . * "*Min. & Sc. Press*," xxxvi. 249.

Scuf'fle Hoe. One having a push motion instead of the downward and pull motion.

Scuffle hoe, *Munson* . . * "*Scientific American*," xl. 389.

Sculp'ture. Mechanical aids in reducing the labor of the sculptor and for copying. See article "*Sculpture*," Laboulaye's "*Dictionnaire des Arts et Manufactures*," vol. iii., ed. 1877.

Article "*Tours Composés*," Laboulaye's "*Dict. des Arts et Manufactures*," iv., ed. 1877, Fig. 42.

Scutch'ing Ma-chine'. One for separating the individual fibers of cotton or flax, which have gone through the preliminary opening process.

Scutching machine, *LeFranc*, "*Iron Age*," xx., July 19, p. 20.

Scut'tle. 1. A small light aperture, closed by a hatch or shutter.

2. A coal bucket

See SIDE LIGHT, "*Mech. Dict.*," p. 2174, *et infra.*

Sea Bat'te-ry. (*Electricity.*) One in which the plates are immersed in the sea, so as to be acted upon by the salt water. Such are used in making luminous signals on buoys, etc.

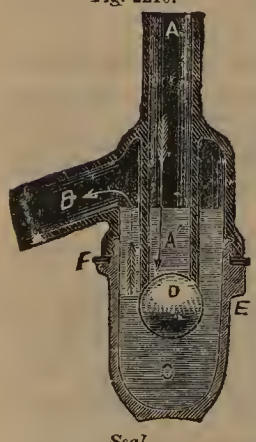
Sea Cock. One opening through the hull into the sea.

Spence's improved sea cocks . * "*Engineer*," xli. 267.

Seal. An automatic valve closing a pipe; or a U-shaped bend in which water collects and prevents passage of air. See SEWER TRAP.

The common siphon trap as used in most sinks and water-closets is subject to two objections: First, the sewer gases in the ascending branch of the trap are in constant contact with the water, and permeate it without hindrance, by which it becomes foul and gives off offensive odors in the other ascending branch of the trap; second, when from some cause or other pressure takes place in the descending branch connected with the sewer, the sewer gas will bubble up through.

Fig. 2210.



Seal.

The inlet pipe connecting with the washstand, sink, or other fixture extends down about half way into the center of an enlarged U-shaped chamber two thirds full of water in which floats a rubber ball fitting tightly up against the end of the inlet pipe, forming a perfect seal. The outlet pipe is in the top of the U-shaped chamber, above the end of the inlet pipe.

See Fig. 5766, p 2374, and Fig. 6618, p. 2616, "*Mech. Dict.*"

Seal Em-bos'sing Press. A press intended to emboss envelopes, or name or initials on note paper, or the stationer's card on any paper they print or furnish. It is worked by a cam and gearing; is very powerful and speedy, and is readily adjusted to any pressure wanted.

Seal Hook. An iron hook which is inserted into the hasp of a freight-car door and to which a seal wire and metal seal are attached.

Seal Lock. A lock in which a seal made of glass, paper, or other material is inserted in the lock in such a manner as to cover the bolt or the key-hole. The lock cannot be opened without breaking the seal.

Seal Press. A pair of levers arranged like a pair of pincers and with two dies with which lead car-seals are compressed on the wire to which they are attached. The two dies leave an impression on the lead so that if the seals are removed or defaced it can be known. — *Forney.*

Seal'skin. (*Fabric.*) The imitation sealskin is made under a process invented by Crosland, of Huddersfield, England, in 1850, by which the short hairs of the cow and calf could be used in the manufacture. The main feature of the process consists in boiling the fabrics for a long time in water, which develops the luster of the fiber.

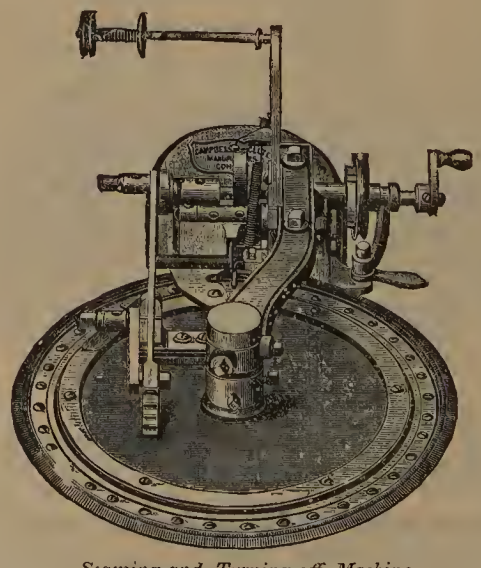
Seal Wire. Several strands of fine wire which are twisted together like a rope, and by which leaden seals are attached to car doors.

Seam'ing. (*Fishing.*) The marginal line which surrounds a seine, and to which the meshes are seized. A *meter* is an outer strengthening line, seized at intervals of a yard. To the meter, on the upper edge, the floats are attached, and to the meter below, the weights.

Seam'ing Ma-chine'. The Rover & Lincoln seamer for use in print works, bleacheries, dye works, and cotton mills trims woven goods neatly and evenly; and joins the margin of cloth outside the seam so that it will pass through the shearing machine without raising the blades.

In this machine the grooved points, on which are placed the loops of the ends of the knit goods that are to be seamed together, are arranged radially and set in a brass ring, which is 16″ in diameter, and is secured in a circular bed that is mounted to turn on an upright axis, and has on its bottom, or lower part, a concentric circle of gear teeth which gear into a pinion fast on a shaft with a ratchet wheel having teeth to suit the gage of the circle of grooved points. This ratchet is turned one step at each revolution of a driving shaft by means of a pawl connected with that shaft, and thereby the circle of points is turned a step equal to the distance from one point to the next so as to bring the next point under the needle. A dog drops into the teeth of the ratchet and prevents the latter and the circle of points from turning backward.

Fig. 2211.



Seaming and Turning-off Machine.

The needle is held by an arm which is mounted on a fulcrum and gets its to and fro motion by a cam on the driving shaft. The looper is held by a separate arm which receives

its motion by a side eam connected to the needle eam, so that the points are fed forward one step, as above described, and a stitch is made by the needle and looper at each revolution of the driving shaft.

The points are firmly held in their places by caps or segments with three screws each. The gage can be changed by taking out the brass ring that holds the points and putting in another with more or less points to make the gage required. The ratchet must also be changed for another having the proper number of teeth to turn the circle of points with the necessary step by step movement corresponding to the change of gage.

The main driving shaft should revolve 115 to 120 times per minute in order to give a good result.

Search'er. (*Surgical.*) A flexible instrument or sound introduced through the urethra to explore for a stone by contact.

Andrew's, *Little's*, *Gouley's*, *Bilroth's*, *Thompson's*, *Otis's*, etc.

Seat Fas'ten-er. Fig. 2212 shows a clamp for holding a wagon seat firmly in position, and for keeping the body from spreading.

Fig. 2212.

Seat Fastener.

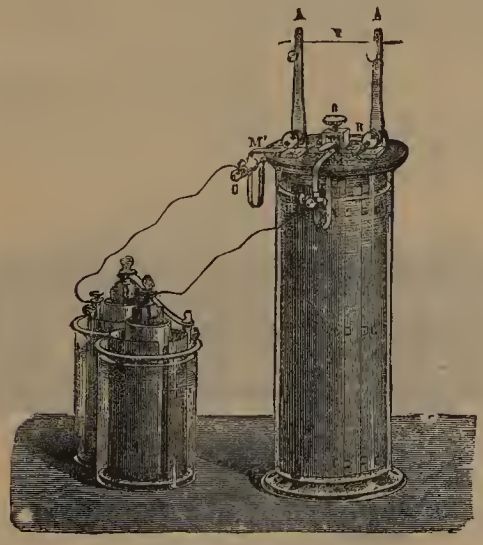
Seat Lock. A lock for holding the back of a seat so that its position cannot be reversed. Such locks are attached either to the seat-end, seat-back arm, or the seat-back stop.

Se-bas'tine. A Swedish explosive made of nitro-glycerine, wood-charcoal, and certain explosive salts. Ignited by fire it burns readily but does not explode. If confined in detonating capsules it explodes with great force. Patented in Sweden in 1872.

Sec'on-da-ry Bat'te-ry. (*Electricity.*) Invented by Plante. A battery having two plates of large surface immersed in an acid solution and charged from a primary battery, the polarization resulting from the primary current serving upon the breaking of the primary circuit and the closing of the secondary circuit to give a reverse current of great electro-motive force, which may be used for lighting, heating, or other effects.

Planté's secondary batteries may be considered as voltameters made of two sheets of lead rolled up in a spiral, so as to give large surface and small distance of plates. They are charged with dilute acid, which is decomposed by a current passed into the plates, producing peroxide of lead on one plate and a film of hydrogen on the other. In this state the cell itself will furnish a current for a short time. By connections which unite the cells of the secondary for quantity during charging, two Bunsen cells arranged for intensity will produce the desired effect. By connection of the secondary in series for discharge, a very powerful current — equal to that of many Bunsens in series — may be obtained.

Fig. 2213.



Secondary Element.

Fig. 2213 shows a secondary element as now constructed. In a tall vessel of glass, gutta-percha, or ebonite, are placed two sheets of lead, rolled spirally, and parallel one to the other, and kept from touching by two cords of india-rubber rolled up with them; these two sheets of lead are immersed in a solution of one part of sulphuric acid to nine parts of water. The vessel is closed by a sealed cover pierced with a small hole, through which the liquid can be poured in or extracted, and which also allows the escape of any gas which may be generated during the charging of the battery. The apparatus is surmounted by a disk of ebonite, upon which are fixed two contact pieces in connection with the two electrodes; two clips are also provided for the purpose of holding metallic wires to be made red hot or melted by the secondary current.

Two Bunsen cells, or, in their stead, three Daniell cells, are required to charge this secondary element. During the operation of charging, one of the electrodes oxidizes, a brown coating of peroxide of lead soon shows itself, and the metallic appearance disappears entirely; the other electrode also changes in appearance, — its surface becomes covered with a powdery gray coating.

When the charge has attained its maximum — that is to say, when oxygen commences to be given off by the brown electrode, it is well to disconnect the secondary element from the charging battery, for any further expenditure of the polarizing current is entirely wasted.

The secondary element once charged in this manner and left to itself will retain a portion of its charge for several days; and even at the end of a week it is still far from being exhausted.

The secondary element, when fully charged, has an electro-motive force equal to one and a half times that of a Bunsen; it will redden a platinum wire of a greater or lesser diameter according to its size, or rather according to the size of the electrodes; for it is of course understood that the quantity of electricity which the apparatus can furnish is in proportion to the extent of the surface subjected to the action of the polarizing current and covered with an active electro-chemical deposit.

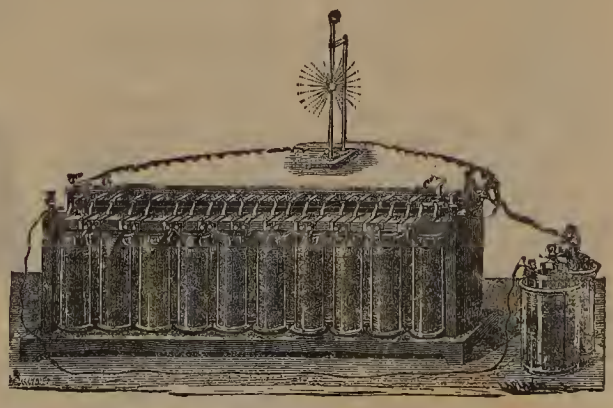
The spiral form of the electrodes gives an element having a large surface and a small resistance within a small space, so that one of Planté's secondary elements is equal to an active or ordinary element of a very unusual size; the small pattern has an active surface of 124 square inches, the large pattern of a surface of 620 square inches.

The current furnished by the secondary element will effect chemical decomposition, act upon an electro-magnet, etc.

A secondary element is all the better for having been charged and discharged a great number of times; at first, when it is almost new, there is an advantage in polarizing the electrodes, sometimes in one direction and sometimes in the other, reversing several times the direction of the charge; but when the element is formed the greatest care must, on the contrary, be taken to charge it always in the same direction.

These secondary elements can be joined together, either for intensity or for quantity, and they form batteries capable of producing all the effects of batteries of the ordinary

Fig. 2214.



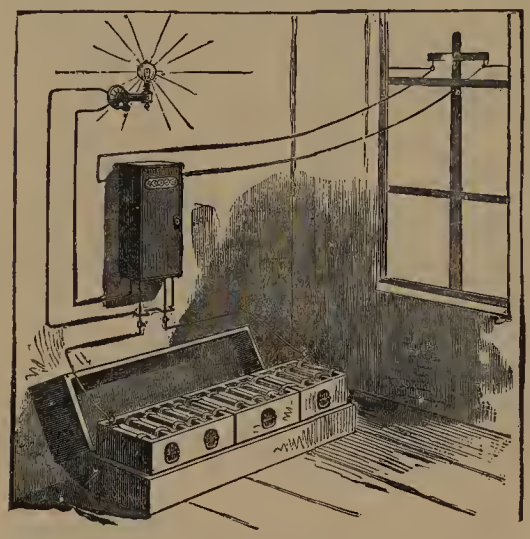
Planté's Secondary Battery.

form, and of the most powerful kind. Fig. 2214 represents a secondary battery as arranged by M. Planté.

Faure, observing that the lead plate of a good battery became coated with oxide of lead, applied oxide of lead to his plates and found that he could make a battery without charging and recharging for months.

Brush claims the invention of a process of effectively preparing his lead plates without any oxide of lead at all. His method is a secret and he claims there is no coating of minium on the plates, the battery can be charged more quickly and discharged more safely, and the process of manufacture is no more prolonged or costly than in the case of Faure's apparatus. The batteries shown in Fig. 2215 are contained

Fig. 2215.



Brush's Secondary Battery.

in a box 8′ long, 15″ wide, and 16″ high. Charged from an arc-light circuit wire, they will feed 27 Swan lamps of 16-candle power, and run a small motor of one-horse power. A series of 20 cells, each cell consisting of two lead plates, about 16″ square in size, is sufficient to supply from 40 to 60 Swan lamps of 16-candle power, or as many lights as a good sized house would require. In connection with Swan lamps, one horse power, if used to run a dynamo connected with a battery, will store up sufficient electricity to run from 9 to 10 lamps. This current can be taken from an arc circuit without interrupting the burning of arc lights; the batteries are placed in the cellars of each house where the light is furnished. Mr. Brush says that the batteries are indestructible, and improve with age, the only attention necessary being the addition of water every few months to take the place of that which has evaporated.

In 1801 Gautherot, a French physician, discovered that platinum or silver wires immersed in a saline solution, after having been used for decomposing the salt, gave a current of their own of short duration upon being disconnected from the battery.

In 1803 Ritter made the first secondary battery by superposing a series of gold disks separated by pieces of cloth dampened with a saline solution. He also employed platinum, copper, brass, iron, bismuth, and silver, and remarked that still better results were obtained with carburet of iron and peroxide of manganese. He obtained no effect with lead on account of the solution which he made use of. He used common salt and sal ammoniac.

In 1859 Planté published accounts of experiments made by him upon most of the metals, and many different solutions for the purpose of determining the best construction of elements for secondary batteries.

In 1860 Planté constructed a secondary battery of two plates of lead separated by cloth and rolled up into a spiral and immersed in a dilute solution of sulphuric acid. He afterwards substituted for the cloth two thin strips of rubber.

In 1861, Kirchhof, U. S. Patent, No. 31,545, February 26. Two roughened, perforated, or recticulated platinum electrodes in a solution of nitrate and acetate of lead, nitrate of potash, acetic and nitric acids and nitrate or acetate of iron or zinc, all suggested. Upon charging, one plate became covered with peroxide of lead, and the other with crystallized lead. He also described a switch whereby the cells could be charged, one after the other, while the others were discharging. Also a commutator for the dynamo whereby the charging circuit was always left open when the machine was not running.

In 1866, Percival, U. S. Patent, No. 53,668, April 3. A box with two compartments separated by a porous partition, and filled with powdered carbon, granular lead, or other conductiug powder moistened with acidulated water. Copper or lead plates immersed in the powder served as conductors.

In 1867, Leclanché, U. S. Patent, No. 64,113, April 23. Two graphite plates in powdered charcoal saturated with potash water, porous partition.

In 1869, Percival proposed to make the positive electrode of some more active metal, such as zinc, and then to use a neutral solution of the positive metal as with zinc, zinc sulphate, with copper, copper sulphate, etc. Upon charging, peroxide of lead formed on the lead plate and finely divided zinc on the zinc plate, sulphuric acid being set free. Amalgamated the zinc.

In 1869, Varley, English Patent, No. 2,525, makes use of plates of paladium or arsenic ou account of their capacity for storing hydrogen. These are used in connection with carbon plates rendered porous for the absorption of oxygen by dissolving out the silica from gas retort carbon by hydrofluoric acid.

In 1876, Jablochkoff, French Patent, No. 112,024, March 23 and October 2, in an electric lighting system places a secondary battery in a shunt around each light.

In 1878, Fox, English Patent, No. 3,988, suggests the use of plates of copper in a solution of bicarbonate of soda. The secondary batteries are connected in a lighting system between the main wires and the ground, thereby serving to store up any surplus energy thrown upon the line.

In 1879, Thomson & Houston, U. S. Patent, No. 220,948, October 28, and English Patent No. 4,400. A series of disks of copper or other suitable metal are arranged one above another, and separated by rings of earthenware, rubber, wood, or other non-conductor. Diaphragms of felt are interposed, and the whole is secured by bolts and end-plates. The solution may be zinc, sulphate, or other similar salt, and must entirely fill the spaces between the plates. When subject to motion the spaces between the plates are filled with sand, pumice-stone, sawdust, or the like. During charging, zinc is deposited on the under side of the plates while the upper sides dissolve to form copper sulphate. In the English patent negative plates of mercury, silver, or lead are proposed, which may be roughened, serrated, or coiled, or may be formed by a tray filled with fragments of the metal. The upper plate may be perforated and varnished underneath. Pieces of hard carbon may be placed upon the upper plate to receive zinc deposit, or spurs or projections may be formed on its upper surface for same purpose.

In 1880, Faure, French Patent, No. 139,258, October 20, applies a superficial coating of lead oxide, spongy lead, or similar active conducting material to the surface of the electrodes, and holds it in place by porous partition.

In 1881, Faure, cert. of add to French patent, February 9, proposes red lead or minium for a coating.

In 1881, Swan, English Patent No. 2,272, May 24. Lead plates, honey-combed, ribbed or cellular, for increasing surface and forming better support for the porous deposit.

It has also been suggested that spongy platinum, amalgamated lead, and zinc or lead wire may be used for electrodes.

Almost any primary battery, whether it be galvanic or thermal, will serve as a means of storing up energy when a current is passed through it in a direction opposite to that of the current which it itself would produce.

It should be remembered that the energy as stored is potential chemical (or in a thermal battery, heat) energy and not electrical; and it is in this respect that it differs from a condenser which, although, like a secondary battery, it discharges a current, the reverse of the charging current, still it does not transform the energy from electricity.

Planté . . . . . * "*Scientific Amer.*," xxxviii. 313.
"*New York Times*," May 13, 1882.
* "*Scientific Amer. Sup.*," 65, 2527.
Telegraphic Journal . . * "*Scientific Amer.*," xxxviii. 313.
Niaudet, Am. transl. . * 243.
Disser. on secondary Batteries . . . . . "*English Mechanic*," xxvii. 476.

Fig. 2216.

Section Cutter.

Sec'on-da-ry Coil. (*Electricity.*) A coil of wire usually wound upon, but entirely separated from the primary coil by insulation.

Sec'on-da-ry Cur'rent. (*Electricity.*) The current emanating from the secondary coil. The *induced* current.

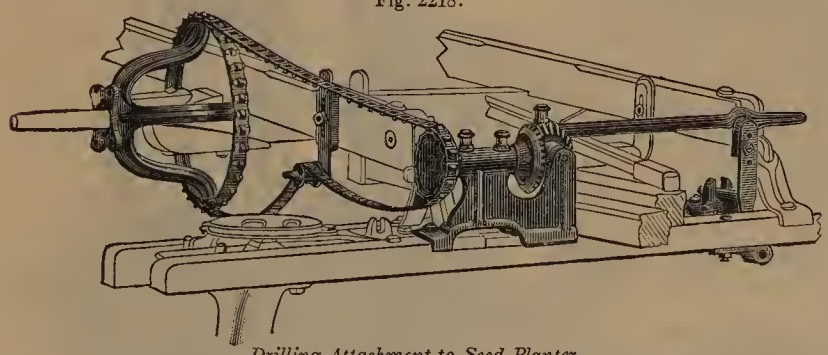
Sec'tion Cut'ter. An instrument for making very thin slices for microscopic purposes.

Valentine's knife is two-bladed, but the most delicate instruments are Walmsley's adaptation of Dr. Bevan Lewis's ether spray microtome.

In Fig. 2216, some thickened gum water being placed upon the top of the tube, a piece of tissue, say a portion of the spinal column from a freshly killed animal, may be placed in it, and the nozzle of the freezing atomizer having been introduced into the tube beneath, the tissue will be solidly frozen in from one to three minutes. Ether may be used, but rhigoline is much better. A considerable portion of it will be condensed in the chamber, and can be drawn off by the tube shown in the illustration, for further use. The knife should be kept cold, by placing on a block of ice before using.

Seed Drill. A machine for sowing various seeds in drills or rows. See GRAIN DRILL.

Fig. 2218.



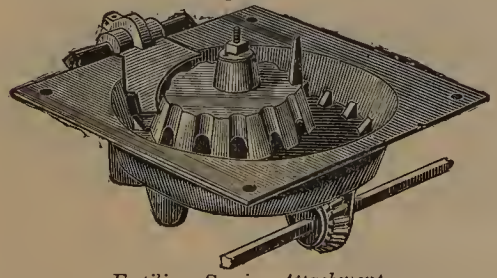
Drilling Attachment to Seed Planter.

Beet-seed drill . .	Figs. 268-270, p. 92, *supra.*
Broad-cast seeder .	Figs. 430-432, p. 136, *supra.*
Corn drill . . .	Fig. 691, p. 222, *supra.*
Corn planter . .	Fig. 697, p. 223, *supra.*
Hand planter . .	Fig. 2382, p. 1037, "*Mech. Dict.*"
Seeding machines .	Figs. 4808-4814, pp. 2088, 2089, "*Mech. Dict.*"
Wheat Drill . .	Figs. 7163-7168, pp. 2761-2763, "*Mech. Dict.*"

Knight's Report, "*Paris Exposition Reports*," 1878, v., pp. 102-119.

Seed Drill (beet) French, McMurtrie's Plate I., Report, "*Department* of *Agriculture Special Report*," No. 28.

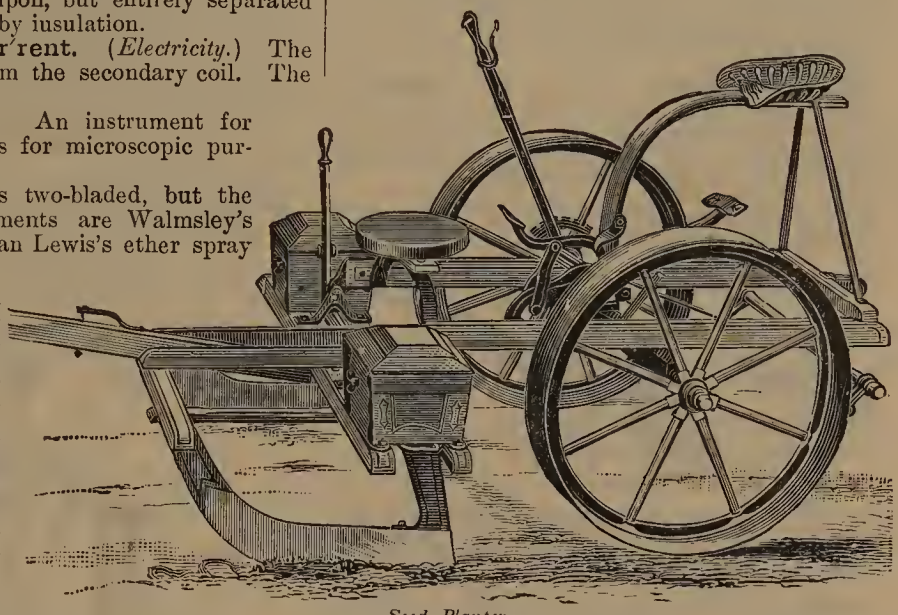
Fig. 2219.



Fertilizer Sowing Attachment.

Seed Mi'cro-scope. A small hand magnifier for examining seeds, or living objects, which are inclosed in a case with glass sides.

Fig. 2217.



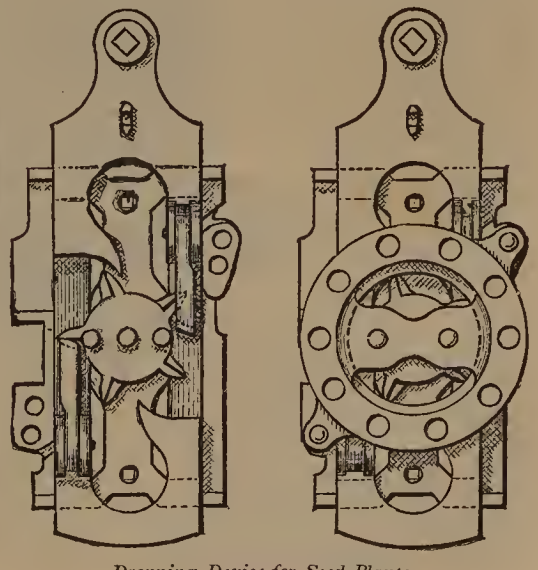
Seed Planter.

Seed Plant'er. An implement for planting in hills in contradistinction to *drilling* or *broadcasting.*

In the Farmer's Friend Planter, of Dayton, Ohio, shown in Fig. 2217, the foot treadle and hand lever are pivoted and work together to raise or lower the runners, which are coupled to the frame with a treadle. Pressing with the feet on the rear of this raises the runners, while power applied to the other by means of an independent foot piece forces them into the ground. A hand lever, held by a spring catch, is pivoted to the treadle. The runners adjust themselves to uneven surfaces, and plant two rows at different levels, each the same depth. The entire weight of the machine can be locked on the runners. Gage plates regulate the depth. Fig. 2218 shows a drilling attachment for use in drilling corn. Fig. 2219, an attachment for sowing fertilizers.

Fig. 2220 represents the dropping device, Fig. 2221 *a*, the same with the seed plate removed. The device consists of a slide resting on a bed plate, and pawls pivoted to the sides of the

Fig. 2220. Fig. 2220 *a*.



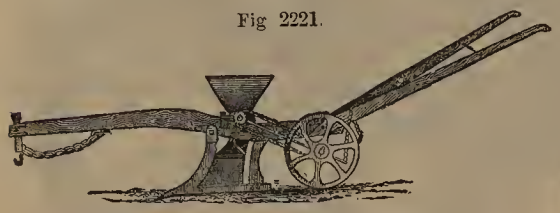
Dropping Device for Seed Planter.

slide for driving the star-shaped casting which carries the seed plate. When the slide is moved, the pawls come in contact, alternately, with the points of the star, moving it round, carrying the seed plate with it, dropping seed at each motion of the slide.

Seed'ing Plow. A single row implement known as a seeding barrow. It is made either with cups or brush. Some of these are intended to follow after a plow or in a furrow laid out, while others have a share which opens the furrow.

The Plow Drill, Fig. 2221, shows an old form of drill of Hindustan, probably the one noticed in use in the watered

Fig 2221.



Seeding Plow.

rice fields of the East, by Aristobulus, one of Alexander's generals. These old drill plows are still in use in southern Asia, and were exhibited at the Centennial and the Paris Expositions from India, Java, and China.

Seg'gar. (*Ceramics.*) A vessel of infusible fire-clay to hold ware while being baked or burned in the kiln.

Seg'ment Saw. An annular saw which is made of segmental plates; as distinguished from a solid plate-saw. A vibrating saw with a curved blade, that formed a segment of a cylinder, was some years since patented in England, but does not seem to have come into use; its purpose was the same as that of the tubular saw.

Seine. (*Fishing.*) This in its simplest form is a flat web of netting, with corks or floats at the upper edge and weights at the lower edge, used to inclose an area of water, and by bringing the ends together, either to a boat or on the shore, to secure the fish that may happen to be in the inclosure.

The seine varies in length from a small minnow seine to a shad seine a mile long, hauled in by a windlass worked by horses, oxen, or by steam engine.

A form of net used in sweeping areas of water. Divided into *haul*-seines and *purse*-seines.

A large haul-seine on the Atlantic sounds and bays is 1,000 fathoms in length, but one at Stony Point, on the Potomac, is 3,400 yards. The seine depends from a cork-line, and the lower edge is weighted with leads which sweep the bottom. A line known as the *toggle*-line is sometimes used, so called from its being secured to the seine at regular distances by toggles. At the ends of the seine are the land-lines, which go to shore and pass round the shears-blocks to the windlasses. At the mid-length of the seine is the *bag* of the net, which comes last ashore. The *wings* are the ends.

Seine Wind'lass. (*Fishing.*) A winch to haul in a seine line.

Seis'mo-graph. An instrument for recording shocks or perturbations.

1. The *seismometer* of Prof. Palmieri, p. 2091, "*Mech. Dict.*," was for detecting earthquake shocks and recording their duration.

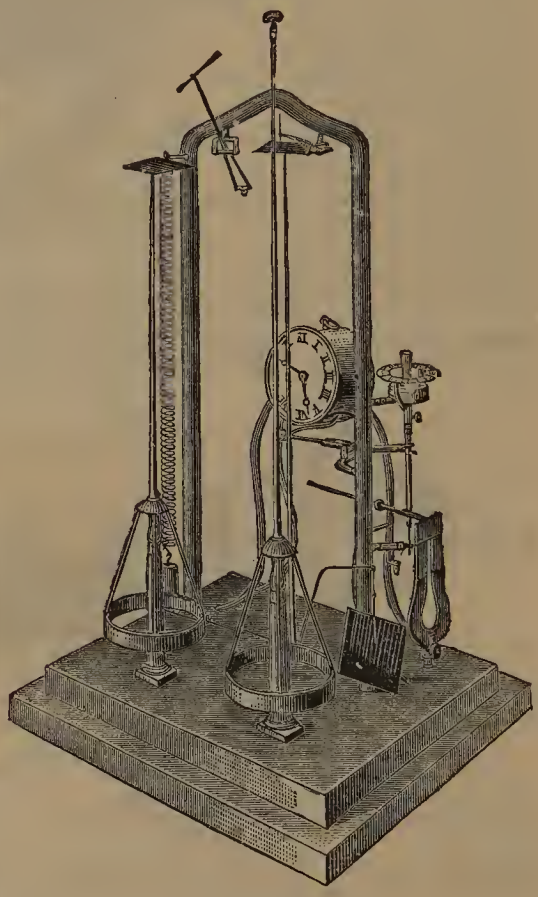
M. Hattori, of the University of Tokio, gives a description of an *earthquake indicator* invented by Choko, about A. D. 132. "It consisted of a copper vessel, the diameter of which was eight shaker or feet, and whose convex cover was ornamented with characters, mountain turtles, birds, and beasts. In this vessel there was one main piston in the middle with its eight branches, wires, and springs. On the outside of this vessel were eight dragon heads, each of them having a copper ball in its full opened mouth. Under each of the dragon heads there was a frog looking upward with its mouth fully opened. The wire works and springs were very skillfully arranged in the vessel, but the cover was closely fitted, and they could not be seen. Whenever the earth shook one of the dragons dropped the ball, the frog underneath received it in its mouth, and produced a sound. By this means the direction of the shocks was ascertained. Once one of the dragons dropped its ball, but no person near it perceived any shock, and all the learned men of the capital doubted the trustworthiness of the machine; but after a few days a mail arrived from Rosei and reported the occurrence of an earthquake there."

Sig. Ignazio Galli's apparatus for registering earthly perturbations at the Meteorological Observatory of Velletri, Italy, consists of six separate devices for observing and recording automatically: —

1. The horizontal amplitude of earth tremors.
2. The vertical amplitude.
3. The direction of the earthquake movement.
4. The time of the shock.
5. The intensity of the attending magnetic disturbance.

At one corner of the marble base is a short standard of metal, on the top of which rests an agate cup, balanced by a

Fig. 2222.



Seismograph.

ring below, and carrying above a long, slender vertical rod, the whole forming a sensitive pendulum. At the top of the rod is a small silver mirror, carrying a fine needle, the movements of which are observed through a small telescope. Any movement of the base is so magnified at the upper end of the rod that the minutest tremors of the earth are thus made visible.

The adjacent device is substantially the same, except that the vertical rod is shorter and carries at top a sheet of paper covered with lampblack. Resting on this blackened paper is the fine needle of a nicely balanced lever attached to the brass support which arches over the middle of the base. As the earth tremor causes the paper to move the relative extent and character of the movement are marked by the needle on its blackened surface. Behind this part of the apparatus is a weight suspended by a sensitive spiral spring. At the bottom of the weight is a lever, to the other end of which a needle is suspended by a hair, the point of the needle resting on a sheet of blackened paper slightly inclined. This is for measuring the vertical height of the earth movement.

The direction of the movement is marked by the needle of the lever attached near the upper right-hand corner of the frame, on the sheet of blackened paper on the top of the rod which rises from the middle of the base.

To ascertain the quarter whence the movement proceeds and the time of the shock, a truncated metal cone is inverted

and balanced on a horizontal metallic disk surrounded by a ring marked with the cardinal points. The instant the apparatus is moved the coue tips against that side of the ring whence the motion proceeds, and in falling acts upon a lever which stops the clock, thus indicating at once the direction of the source of the shock and the time of its occurrence. The intensity of the accompanying magnetic disturbance is measured by the magnet and its attachments. This seismograph is inclosed in a glass case, is small, extremely sensitive, and records the slightest tremors of the earth with great precision.

The Bregnet seismograph, exhibited at the Paris Exposition, 1878, is an instrument for measuring and electrically registering the deviations of a long pendulum under the influence of terrestrial movements or solar-lunar attractions.

It consists of a heavy pendulum suspended by a wire from a support above and carrying a pointer below which traverses in close proximity to a horizontal sheet of white paper, traveling over a flat metallic plate, by the rotation of a pair of rollers in gear with the train of a clock. The pendulum and metallic plate are insulated from one another, and are respectively connected to the two terminals of a small induction coil, which is, by the movement of the clock, periodically placed in circuit for a few seconds with a battery.

When this takes place sparks pass through the paper, between the pointer of the pendulum and the metallic plate, causing a series of perforations on the paper band, forming a record.

"*Telegraphic Journal*" . . . . . vi. 499.

2. The name is also applied to an instrument, invented by Carlisle (England), for recording the shocks received by or the oscillations produced in a vehicle, a railway carriage for instance, when in motion.

Its action depends upon the inertia of a suspended weight attached by an elastic medium to a point of support. If such a point be shifted suddenly in any direction, the suspended body, from its inertia, retains for a moment its original position, and only gradually recovers its relative position to the point of support, and that with an amount of force varying according to the distance through which, and the velocity with which, the point of suspension has been disturbed.

By a mechanical arrangement this force is made to move a pencil at right angles to a straight line which the pencil when at rest is describing upon a strip of paper traveled at a determinate rate by clock work. By this means the time as well as extent of the oscillation is recorded.

A is the base plate and *B* the standard, to the latter of which the weight *C D* is attached by gimbal-joint, allowing it to swing freely. The outer ring *E* of the gimbal is pivoted to the frame at *F F* and the inner ring to the outer, as usual. The weight *C* has a light barrel *D* both turned true to an axis, and the swinging end is supported at the point *G* by springs *H H* suspended from an arm *I* secured at *K* to the frame *B*. At the end of the weight *C* is a hollow axial projecting stud *L* which serves to limit the oscillation of the weight by contact with the ring *M*. When it is desired to lock the weight so as to put the instrument out of action, the lever *P* on shaft *O* is moved, throwing the pin *N* into the hollow of the stud *L* and holding the weight rigidly. The play of the stud *L* in the ring *M* is about 1.25″ in every direction from the axis.

The inner ring of the gimbal is turned out at the rear so as to form a flat annular surface against which a disk is pressed by the spring *V*, and this disk is supported by an arm projecting from the upright rod *a*, a portion of which shows in the figure. Near its upper end the rod *a* has another horizontal arm *b* which connects at point *r* with a rod *c* to move the arm *d* which carries the pencil *e*.

Any movement of the weight swinging on its gimbal-joint produces a thrust motion upon the disk which is pressed against the rear of the gimbal ring, and this motion is transmitted to the pencil by the means just described. The pencil-arm *d* is mounted on the axis *f*, which is surrounded and moved by a spiral spring which brings the pencil back to the base line on the paper after each lateral movement, and an adjustment at *r* in the slotted end of the lever *b* permits the arm *d* to be so adjusted as to show, either all the oscillations indicated by the weight, or only such of them as exceed a certain limit. An index finger *q* and a graduated arc, *s*, afford means for regulating this adjustment with accuracy.

The strip of paper *i* is moved by rollers and clock-work. One of these rollers *l* makes a revolution once in 5 minutes marking minutes on the paper by 1 prick and 5 minutes by 2 pricks. The paper delivered by one roller is taken up by roller *m*.

To observe oscillations, both vertical and horizontal, the instrument is placed on the floor of the car, its axis parallel with the direction of movement. To obtain only vertical oscillations the axis of the weight is across the car and blocks are placed to restrain lateral movement.

The time of starting being noted on the paper, and the clock-work being started coincidently with the engine, the strip is a record of the trip. The instrument is used to test the condition of a track, the personal equation, so to speak, of the machine being known; or that of the track being known or assumed, to test the relative steadiness of different engines or cars passing over a specific portion of the road.

Reference may be made to:—

* "*Engineering*," xxii. 160; xxvi. 426.

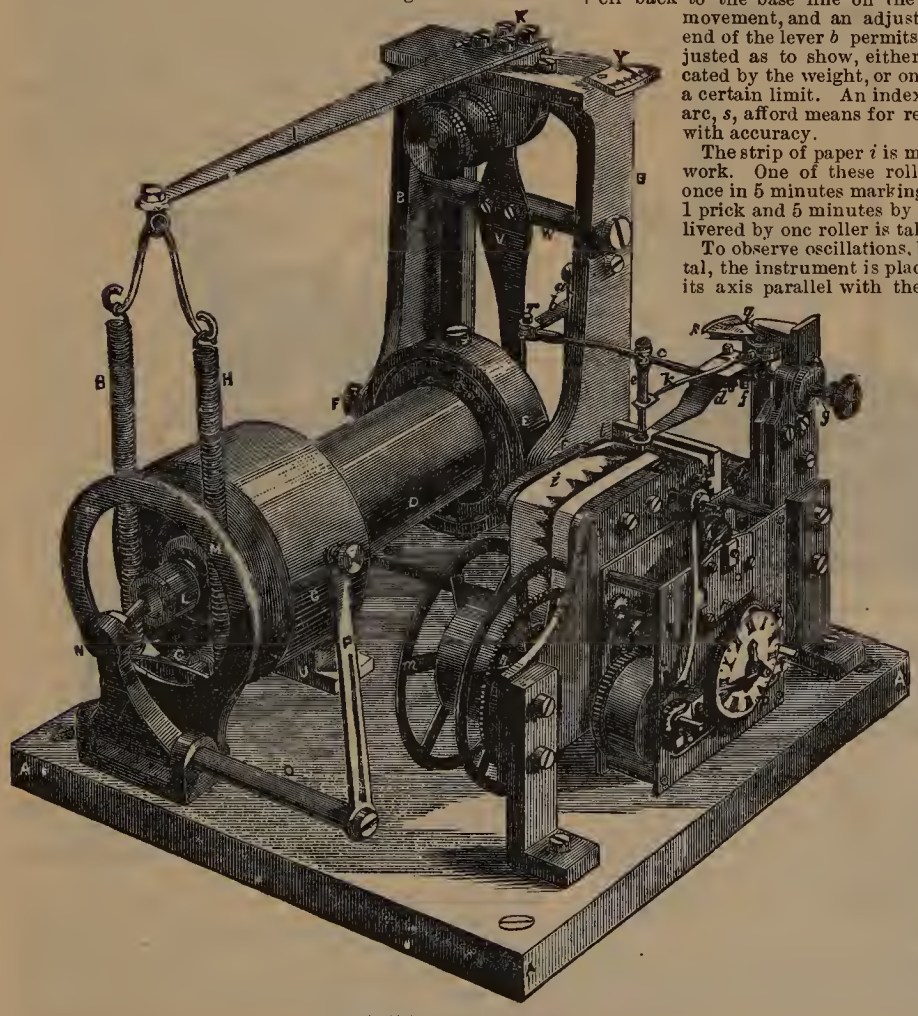
* "*Scientific American Supplement*," 646.

* "*Railroad Gazette*," viii. 411.

U. S. Patent, 222,292, T L. Luders, Shock or Jar recorder, Dec. 2, 1879.

A very striking instrument for testing the road-bed of railways, the trac-

Fig. 2223.



Carlisle's Seismograph.

tive force required on curves and grades, and other similar data is the dynagraph car of Mr. P. H. Dudley.

The indications of the instrument are by no means confined to those given by the Carlisle instrument where the vertical and lateral oscillations of the car under inequalities in the road are interpreted as shocks or perturbations; but it affords numerous additional data for calculations, all of which are drawn graphically on paper by pens which are intermediately connected to the draw-bar of the car or worked by electricity.

The draw-bar is connected with a piston which works in a cylinder filled with oil, the pressure is transmitted through a pipe to another cylinder over a table in the car, and a piston is connected with a pen, which marks on a roll of paper the resistance of the train. Other pens indicate the space passed over each second, each 10 seconds, and each minute, each revolution of the driving wheels, each mile passed, the alignment of the road, the quantity of water consumed by the engine, the quantity of coal used, the resistance of the wind, etc. See DYNAGRAPH.

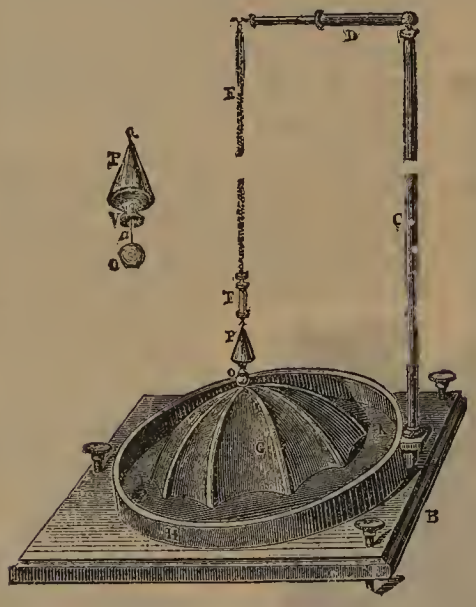
Seismograph, *Carlisle* . * "*Railroad Gazette*," viii. 411.
* "*Engineering*," xxii. 160.
Eastern Ry. of France * "*Engineering*," xxvi. 427.

Seis-mom'e-ter. An instrument for measuring cosmic perturbations or shocks. See SEISMOGRAPH.

The application of the microphone as a seismometer is referred to in "*Engineering*," xxix. 498.

Fig. 2224 shows the earthquake indicator of Count Malvaria, of Bologna, Italy. The table is adjusted level by the set screws, which serve as feet. Upon it is a circular inclined plane, *K*, surrounded by a rim, *H*, and carrying in its center a reversed hemispherical cup, *G*, the surface of which is divided into eight channels which are placed so as to correspond with the eight principal points of the compass. The

Fig. 2224.



Malvaria's Seismometer.

summit of the cup is provided with a metallic point which enters a shallow indentation in a ball, *O*. The ball is maintained in place by the concave lower portion, *V*, of a weight, *P*, resting upon it. The weight is sustained by the chain *E*, which is supported by the standard *D C*, and adjusted by the screw *F*.

To set the apparatus, it is arranged as depicted in the engraving, the weight pressing upon the ball just sufficiently to hold it on the apex of *G*. The instant, however, a trembling of the earth occurs, the ball rolls from under the weight, down a channel in *G*, and thence to the inclined plane *K*, through an aperture, *L*, in which it falls, striking spring mechanism, and so firing a gun, or else acting upon a clock so that the latter is caused to stop, thus registering the exact moment of the shock.

In order to determine the direction of the vibrations, a fine hole is made, from bottom up, in the weight *P*. In this a needle, *a*, is placed so that its end rests upon the ball, although its body is then pushed up into the weight aperture. When the ball falls, the needle drops also, but is held by its enlarged head, so that it cannot escape from the weight. It rests, however, in the groove on the cup *G*, down which the ball has rolled; and as this groove must be opposite in direction to that pointing to the course of the impulse of the soil, the true bearing of the vibration is at once determined.

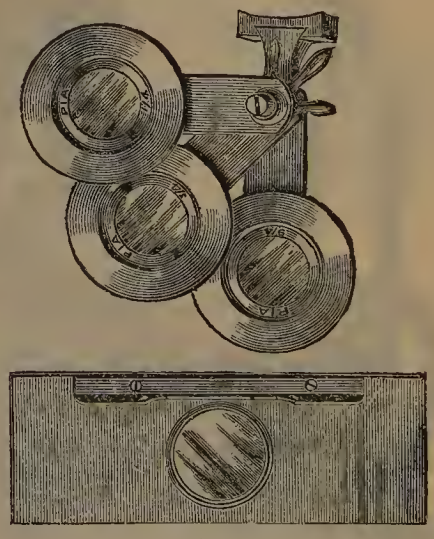
The instrument is said to possess great accuracy, and, doubtless, will serve important ends in localities subject to earthquakes.

Seis'mo-phone. An instrument for distinguishing and locating subterranean sounds, such as that of flowing water, subterranean explosions, etc.

In India, a business is carried on by men called spring-seekers, who generally succeed in designating the subterranean place where water may be obtained; they lie down on the ground and found their judgment on their hearing, which becomes extremely acute by practice. A few years ago, on the occasion of an earthquake at Bagneres-de-Bigorre, in the Pyrenees, Mr. Maxwell Lyte had the idea of placing on the ground an instrument resembling a gigantic stethoscope, and was able to hear the crackings of the terrestaial crust. To M. De Rossi was reserved the honor of raising those empirical attempts to the height of a science, by applying the microphone to the exploration of the soil in its hidden depths. The learned founder of the "Bullettino del Vulcanismo Italiano" commenced his researches in his Observatory of Rocca di Papa, near Rome, and was very soon able to distinguish three different sounds which he could connect with the various movements of his seismatic pendulums. He was able afterward to confirm his results in observing the microphone at Vesuvius, and the solfatara at Pozzuoli, where the movements of the earth's crust are very frequent. Without going any further into the details of that memoir, we must mention the fact that very strong subterranean explosions were heard through the microphone immediately preceding a shock of earthquake. Although M. De Rossi is too prudent to assert the fact, he gives us a glimpse of the possibility of thus predicting approaching cataclysms. However that may be, the *savant* has conferred on science a new means of study which ought to be employed at all meteorological observatories. By establishing facts which have hitherto escaped us, we may perhaps succeed in explaining the causes, still so mysterious, of earthquakes.

Sel'e-nite Stage. (*Optics.*) A film of selenite mounted between two pieces of glass fitted into a brass stage and laid under an object when

Fig. 2225.



Selenite Stage.

viewed under polarized light with the microscope; according to the thickness of the film the resulting colors are either blue and yellow, or red and green, or any intermediate tints with their complementaries.

Se-le'ni-um Eye. A name given by Dr. C. W. Siemens to a small apparatus, in imitation of the natural eye, in which a disk formed by a drop of fluid selenium compressed between mica plates, and with proper electric connections, is made, by the electro-sensitiveness of the selenium

to light, to operate two eyelids when exposed to a flash of light, imitating spontaneous blinking of the natural eyelids.

Paper by Siemens, *Royal Institution of Great Britain*, meeting in February, 1876. Report in "*Engineering*," xxi. 161.

Self-act'ing Boil'er Feed'er. An automatic device in connection with the boiler and the feed-water tank, that as the water is reduced below a given level, a valve at the exit of the feed-pipe that has been kept shut by the pressure of the water, opens, and the steam finds passage through the pipe into the feed-water, which has a lower temperature. It will then, although partly condensing, press upon it with the steam pressure as in the boiler, and the water is forced through the feed-pipe into the boiler till the equilibrium is again regained.

Self-act'ing Lathe. A British name for an automatic lathe, having shaper-plates to govern the cut of the tool.

Shaw & Co. . . . . . * "*Engineering*," xxi. 406.

Self Bind'ers. Reaping machines which automatically bind the grain as cut. See BINDERS and REAPERS, *supra*.

To show to what immense proportions the manufacture of binders, reapers, and mowers has grown in the United States, we give below the dimensions of the establishments of one of the great firms, the Champion Machine Shops of Springfield, Ohio, the outgrowth, we might say, of the industry of William N. Whitely, whose sole stock of capital, a few years since, was his untiring energy and wonderful fertility of invention.

The six establishments, located in the city of Springfield, Ohio, and devoted exclusively to the production of the Champion Harvesters, constitute one of the largest manufacturing interests in the world. The various factories comprised the following grand total of floor space on January, 1883: —

	SQUARE FEET.
Champion Machine Co.	317,450
Whitely, Fassler & Kelly	1,000,500
Warder, Bushnell & Glessner	485,170
Champion Malleable Iron Co.	140,985
Champion Bar and Knife Co.	160,590
Total	2,104,605

Thus the combined Champion interest occupies a grand aggregate of floor space in the manufacture of Champion Harvesting Machines of 2,104,605 square feet, equal to a room 42,092′ long by 50′ wide, or a building 50′ wide by about 8 miles long, constituting the largest industrial shops in the world. Aside from the figures given, the Champion interest have 50 acres of ground used for lumber yards, railway sidings, and sheds.

The following exhibit of the different kinds of material annually consumed by this interest, based upon the consumption of 1882, cannot but impress the reader with the magnitude of the business done by the manufacturers of the Champion Machines: —

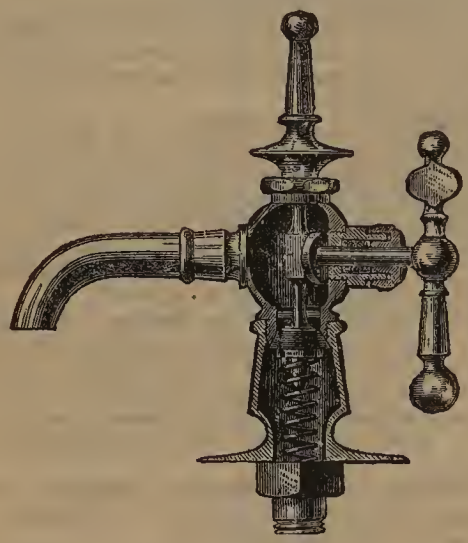
Pig iron	22,000 tons.
Steel	3,100 tons.
Wrought iron	8,200 tons.
Malleable iron	6,550 tons.
Lumber	9,000,000 feet.
Painting materials	221 tons.
Coke	3,850 tons.
Coal	32,600 tons.
Molding sand	6,810 tons.
Grind stones	1,150 tons.
Rivets	212 tons.
Screws	31,400 gross.
Brass spring wire	33,000 lbs.
Paper (apportioned as follows:)	200 tons.
Illustrated Champion	95 tons.
Books and pamphlets	75 tons.
Circulars and blanks	20 tons.
Stationery	10 tons.

The force of employees in 1883 numbers about 3,000, exclusive of the large corps of agents employed in selling the machines. The monthly pay rolls of the combined institutions will average $148,000, or an annual sum paid out for mechanical labor amounting to nearly a million and a half dollars.

Self Clos'ing Fau'cet. One having a valve held to its place by a spring to guard against waste of water through liability of being left open.

The Fuller-Meyer faucet shown in Fig. 2226 is self closing and cannot be forced open by any sudden pressure of water,

Fig. 2226.



Self Closing Faucet.

such as may be experienced where the Holley and similar systems of waterworks exist. Should the spring become weak or broken it may be kept closed with the handle.

Self Dump'ing Coal Tub. Tubs arranged to dump automatically at a desired point.

Fig. 2227 shows the handles pivoted in such manner that the tubs as long as running on their wheels maintain an up-

Fig. 2227.

Self Dumping Coal Tub.

right position, but when the end of the track is reached the weight turns them on the tubs' axes and dumps them.

Self Lock'ing Hook. One which automatically closes the opening over against the point of the hook. See MOUSING HOOK.

Self-lock hook, *Haines*, * "*Scientific American*," xlii. 339.

Self Mous'ing Hook. A hook having an arm depending from its top part, to enter a hole in the upturned end of the hook and prevent the end spreading under heavy strains.

Self Oil'ing Bear'ing. One in which the oil is placed in a receptacle and fed automatically to the point desired in quantity desired.

In Lane and Bodley's oiler, an oil cell is formed below the matrix of the shaft, in the casting from the bearing. Communicating with this oil cell are drilled a number of small holes, about 1-16 of an inch diameter. At the ends of the bearing proper there are the usual dripping cells communicating with the oil cell mentioned for the return of the oil after it has passed through the bearing. The oil, when the shaft is running at high speed, is drawn rapidly up through these small holes, and circulates through the bearing at a rate much more rapid than can be attained with fibrous feeding wicks. Its adaptation for the bearing of line shafting has been very fully demonstrated.

Sel'vage. (*Mining.*) A thin vein of earthy matter between the vein and walls.

Sem'a-trope. An adaptation of the heliotrope. An instrument designed for army signaling purposes. The object is obtained by reflecting the rays of the sun in any given direction.

Sem'i-fixed. Said of a steam engine bolted to an iron foundation piece on which it may be moved intact. Wheels would constitute it *portable*. *Semi-portable* is used by some makers in the same sense as *semi-fixed*.

Sem'i-mul'ti-flue Boil'er. A steam boiler whose outer shell and internal flue are cylindrical and the ends flat; the front part of the flue is arranged with a fire-grate like the Cornish or Lancashire boilers, but, unlike these, a flue-plate is fixed in the flue a short distance behind the furnace, and a number of wrought-iron or brass flues pass from this to the back of the boiler.

Sem'i-mul-ti-tu'bu-lar Boil'er. A term applied to those boilers in which a portion of the cylindrical shell is occupied by flues. It is a pity that the proper distinction between *flues* and *tubes* is not maintained in the nomenclature; *flues* are for flame, *tubes* for water. See SEMI-MULTIFLUE BOILER.

Sem'i-port'a-ble Steam En'gine. One movable on its foundation-plate; as distinct from the *portable*, which is on wheels.

Semi-portable engine.
Garrett, Br. . . . . * "*Engineer*," xliv. 426.
Deakin, Parker & Co., Br. . . . . * "*Engineer*," xlvii. 248.
" Eclipse " . . . . * "*Scientific Amer.*," xxxviii. 214.
Garrett, Br. . . . . * "*Engineering*," xxvi. 470.
Semi-portable Steam engine, *Baxter* . . . . * "*Engineering*," xxiv. 49.
Roberts . . . . . * "*Scientific Amer.*," xxxviii. 342.

Sem'i-ro'ta-ry En'gine. An engine between a reciprocating and rotary one. The piston has a forward, then an up-and-down and backward movement. It is a very compact engine, with few wearing parts, and is governed expansively.

* "*Scientific American*," xxxiv. 223.
Higginson, Br. . . * "*Engineer*," xli. 115.

Sem'i-tu'bu-lar Boil'er. A name applied to a system of boilers in which the water, first heated in a cylindrical shell boiler, passes thence to a second boiler provided with flues; the intention being that the water shall deposit its sulphates and carbonates in the first boiler, which is more readily cleaned. See instance in "*Engineer*," * xlv. 392.

Sem-o-li'na. A grade of middlings or cracked wheat. To indicate how difficult it is to define the grade, it may be said that Haggenmacher's *semolina purifier*, a famous machine in Austro-Hungary, at one operation divides the meal into four grades of first-class semolina, four of second-class semolina, and two sizes of offal. See cut in "*American Miller*," vi. 35.

Semolina separator . . * "*Scientific American*," xxxv. 405.
* "*Scientific American Sup.*," 327.

Sen'si-tom'e-ter. The invention of M. Wanerke. A species of actinometer for measuring the relative sensitiveness of films.

It consists essentially of different thicknesses of gelatine impregnated with lampblack, and used for photographic purposes. The *actinometer* proper is for measuring the relative actinic powers of light. See ACTINOMETER, "*Mech. Dict.*," p. 11, *et supra*, p. 4. The *Photometer* is for measuring the relative luminous powers of lights. See PHOTOMETER, "*Mech. Dict.*," pp. 1687, 1688, *et infra*.

The gelatine films of various thicknesses, as above described, are placed in little squares on a glass plate. On each square is printed a number corresponding with the thickness of the gelatine, and consequently when two sensitive films are successively exposed behind the plate for a given time that one which upon development shows the highest readable number is the more sensitive.

Sep'a-ra-ting Disk. (*Dentistry.*) A disk of emery journaled in the yoke of a handle and connected by a coil wire to a rotating motor. The disk can, during its rotation, be turned at any angle required in cutting a space between teeth.

Serge Ar'mure. (*Weaving.*) A style of weaving made on a three-harness loom, and producing the serge tissue. (See ARMURE.) In one form of French worsted goods, for instance, the warp has a serge armure of 2 and 1 and the weft a serge armure of 1 and 2.

Ser'pen-tine Mold'ing Ma-chine'. One for carving parlor frames, lounge, sofa, and chair backs, and other crooked work. One form has right and left-handled spindles to allow of turning with the grain of the wood. A guide-piece regulates the depth of cut. The work is held and fed by hand, and the tables are adjustable in height. The machine runs about 5,500 revolutions per minute.

Serres-fines. Ordinarily electricity is applied to the surface of parts only, whether these be external or internal. In some more uncommon cases, however, it is found desirable to penetrate the substance, and pass the current in among the tissues; which is done by certain fine needles, in form and size somewhat as in the engravings here annexed. These are used when it is desired to produce a more speedy effect on certain chronic swellings, as the goitre, when the negative pole is attached to the needle, and certain changes of a chemical nature, with a disintegration of tissue, are effected; so as to cause a resolution, and more rapid absorption, of the gland or part. These may be passed in singly, or two or more be used simultaneously, as in acupuncture. They are made of platina, or steel heavily gilt.

Fig. 2228.

Serres-fines.

Fig. 2229.

Garrigues' Serres-fines.

Dr. Garrigues' improved serre-fine is a form for use where the needle cannot be well used. The chief objections urged against the old form of serres-fines in the treatment of rupture of the perineum had been, that they slipped, caused intolerable pain, did not catch sufficiently deep, cut through, and that the wound did not heal. He thought the chief reason why these objections had appeared was because of the shape which the instruments had heretofore had. If they have no claws, or too short legs, they will slip. They give pain and cut through if the wire is too strong, and the edges of the wound do not unite if the legs of the serres-fines are too short.

The instruments shown have legs which project half an inch, and are armed with minute claws, the spring force is so small that they can be attached to the flesh anywhere, and be worn without pain. The advantage claimed for these serre-fines in the treatment of ruptured perineum is, that they are so simple that it is not necessary even to tell the patient that they are applied.

Ser'vice Box. In the pipes used in the Holly system of generating steam at a central station, and distributing it through underground mains over the city for heating and cooking purposes.

An expansion junction service box is placed at intervals of 100′ to 200′. This provides for the free longitudinal expansion and contraction of the mains, and from this box the service pipes are carried underground to the basement of buildings to be heated. The service pipes, having an adjustable hood inside the junction box, may be turned downward, thus taking up the water of condensation as fast as it

accumulates, and carrying it forward to the regulator valve inside the cellar walls. At this point the water of condensation being at the degree of heat due to 50 lb. pressure to the square inch, is wire drawn, and by this reduction of pressure it is largely reconverted into steam, and is carried on to the radiators, where it is again condensed. By this device it will be seen that although 50 lb. pressure is carried in the mains, it may be reduced to one or two pounds in the building, and therefore in a house two or three miles distant from the boiler there will be precisely the same result as in a building only a few feet away. The consumer living near the boiler house will have no advantage over the consumer living a mile away, since each will ordinarily carry the same house pressure, and consequently at the same temperature. The system was first tried with a three-mile main in Lockport, N. Y., in 1877, but has since been introduced into a number of other cities.

Ser'vice Clean'er. (*Gas.*) An air pump on a bell-shaped receiver fitted with a cock and having attached a strong caoutchouc hose. The object is to free service-pipes of obstructions arising from condensation of hoar frost or otherwise. The mode of using is to use the pump awhile, then open the cock quickly and allow the air condensed in the receiver to suddenly expand into the pipe, when it drives before it the obstruction.

Ser'vi-ette Ma-gique'. A cloth for polishing metallic ware. A piece of woolen cloth is saturated with soap and tripoli and colored with fuchsine.

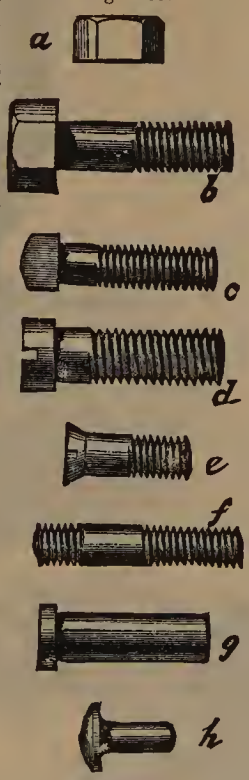
Sixty grains of Marseilles soap to 300 grains of water and 30 grains of tripoli. Saturate the cloth and then dry it.

Set. (*Leather.*) To set a side of leather, it is spread upon the table or stone when wet, and is smoothed out on it by the vigorous use of the slicker, and, owing to its wet condition, the air is easily excluded from under the leather, and it sticks to the table. A thin layer of oil will serve the same purpose.

Set Line. (*Fishing.*) A line laid out in the water in contradistinction to a *hand-line*. See TRAWL LINE.

Set Screw. One to hold some adjustable tool or piece of machinery in place or move it into position.

Fig. 2230.



Set Screws.

a. Hexagon nut.
b. Hexagon-headed set screw.
c. Square-headed set screw.
d. Cheese-headed set screw.
e. Countersunk or cone-headed set screw.
f. Turned stud.
g. Joint pin.
h. Oil pin.

Fig. 2231.

Setting Die.

Set'ting Die. For inserting patent rolled rim conical pointed sheet brass grommets. Fig. 2231 shows setting die for oblong grommets.

Sew'er. A subterranean channel to carry off the refuse slops, surface waters, and other waste liquids and excrement in cities.

See "*Mech. Dict.*," 2097, 2098, and article "*Égouts*," * tome iv., ed. 1877, Laboulaye's "*Dict. des Arts et Manuf.*"
Prof. Corfield's "*Sewerage and Sewage Utilization*," New York, 1875.
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Phillips. "*On the Drainage and Sewerage of Towns.*"

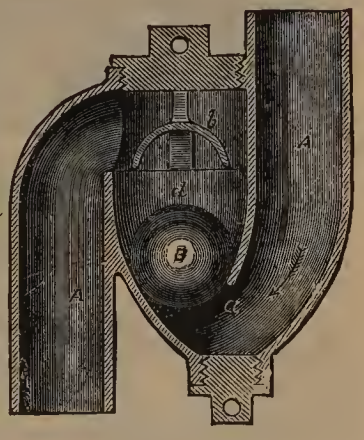
Sewers, construction of.	
Smith, "Iron" . .	"*Van Nostrand's Mag.*," xx. 390.
Schirrmeister . . .	"*Scientific American*," xliii. 82.
Sewerage works, Croydon, Br.	* "*Engineer*," xlvi. 112.
Sewerage and water supply devices, *Rawlinson*, Br.	* "*Engineer*," xlix. 420.
Sewerage and water supply, *Rawlinson*, Br.	* "*Engineer*," l. 25, 32.
Sewer basin and stench-trap, *Dark*	* "*Scientific Amer.*," xxxviii. 281.
Sewer gas stopper. *Wemple*	* "*Scientific American*," xli. 40.
Sewage question. *Bazalgette*	"*Van Nostrand's Mag*," xvii. 106, * 213, * 289.
Sewage system, pneumatic, *Shone*, Br. . .	* "*Engineering*," xxviii. 51.
Sewage system of Paris. "*Engineering*"	"*Van Nostrand's Mag.*," xix 124. "*Scientific American Sup.*," 2238.
Sewage treatment . . .	"*Scientific American Sup.*," 1022.
Sewage, treatment of. Manchester, Engl. .	"*Scientific American Sup.*," 1251.
Various systems. *Bazalgette*	"*Van Nostrand's Mag.*," xvi. 302.
Sewage works for small towns, *Baldwin & Co.* Engl.	* "*Scientific American Sup.*," 1192.
Sewage works in Germany, "*Builder*" . .	"*Van Nostrand's Mag.*," xx. 262.
Sewage, appa. for removing suspended matter from	* "*Engineer*," xlix. 456.
Sewage cleaning appa. *Parrot & Good*, Engl.	* "*Scientific American Sup.*," 3872.
Sewage drying apparatus. London	* "*Engineering*," xxii. 427
Sewage farm, Bedford, Engl.	"*Scientific American*," xxxix. 197.
Sewage irrigation . .	* "*Scientific Am.*," xxxvi. 352, 357.
Sewage into cement . .	"*Scientific American*," xxxix. 200.
Sewage process, phosphate, Br.	"*Van Nostrand's Mag.*," xvi. 34.
Sewage pumping engines. Single action plunger, Twickenham, Br. . .	* "*Engineering*," xxix. 22.

Sew'er En'trance. A pivoted trap-door fitting lightly in a box to prevent the escape of gases and afford an entrance to the sewer.

Sew'er-gas Check. A valve to keep reflux water from rising in the pipe.

The ball *B* sets in the bottom of the U-shaped bend *d*, and rises with the outward flow of water, being checked by the cowl *b*. When the

Fig. 2232.



Sewer-gas Check.

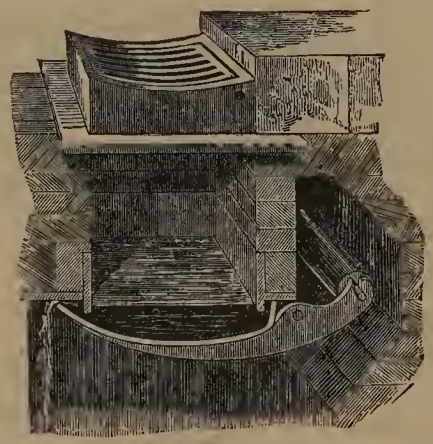
outward flow ceases, the ball drops into its seat, fitting closely, and preventing a reflux of water or the rising of gas. See SEAL, *supra*.

* "*Scientific Amer.*," xxxviii. 243, * 105.
Basin trap * "*Mech. Dict.*," Figs. 238, 239, p. 82, *supra*.

Sew'er Trap.

Fig. 2233 shows a swinging trap balanced at one side of the sewer. The rear end is recessed into the wall, and heavy enough to hold the front part up against a shoulder provided.

Fig. 2233.

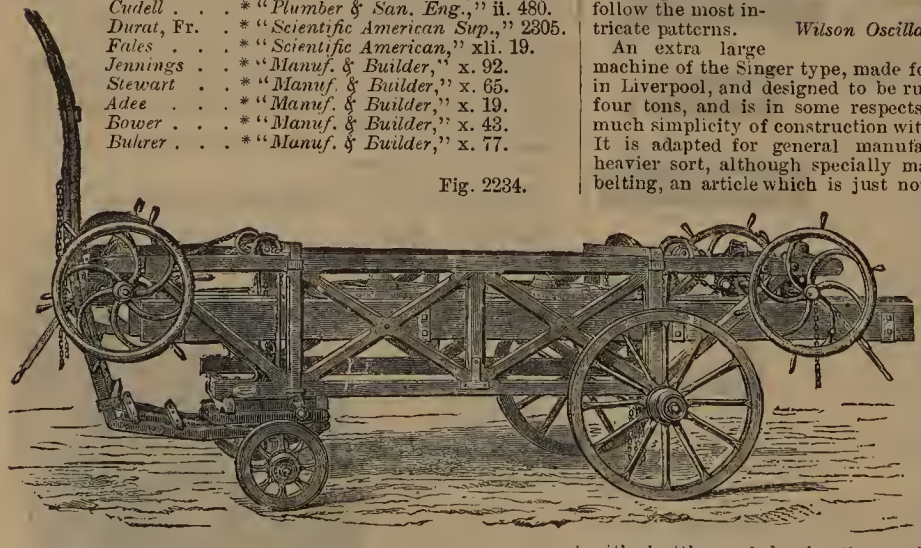


Sewer Trap.

The trap has a concave upper face to retain water enough to seal the outlet from the upward flow of gases or stench, but yields to allow surplus water to flow down.

Sewer-gas trap, *Bower* . * "*Engineer*," xlv. 110.
Bedell . . . . . * "*Scientific American*," xxxv. 182.
Buhrer . . . . . * "*Iron Age*," xxi., April 25, p. 9.
Campbell . . . . . * "*Scientific American*," xxxiv. 118.
Sewer mold, *Burns* . . * "*Scientific American*," xlii. 162.
Sewer trap, *Bower* . . * "*Plumber & Sanitary Engineer*," ii. 165, 445.
Clement . . . . . * "*Plumber & San. Eng.*," ii. 458.
Maddock . . . . . * "*Plumber & San. Eng.*," ii. 147.
Bedell . . . . . * "*Plumber & San. Eng.*," ii. 458.
Jennings . . . . . * "*Plumber & San. Eng.*," ii. 146.
Hellyer . . . . . * "*Plumber & San. Eng.*," ii. 459.
Stewart . . . . . * "*Plumber & San. Eng.*," ii. 480.
Pitt . . . . . * "*Plumber & San. Eng.*," ii. 164.
Gorman . . . . . * "*Plumber & San. Eng.*," ii. 480.
Cudell . . . * "*Plumber & San. Eng.*," ii. 480.
Durat, Fr. . * "*Scientific American Sup.*," 2305.
Fales . . . * "*Scientific American*," xli. 19.
Jennings . . * "*Manuf. & Builder*," x. 92.
Stewart . . * "*Manuf. & Builder*," x. 65.
Adee . . . * "*Manuf. & Builder*," x. 19.
Bower . . . * "*Manuf. & Builder*," x. 43.
Buhrer . . . * "*Manuf. & Builder*," x. 77.

Fig. 2234.



Sewer Shaft Wagon.

Sew'er Shaft Wag'on. A form of wagon for hauling and lowering into the ditch a section of sewer or drain tubing, as shown in Fig. 2234. The axle is bent so as to swing the box below it, elevators at each end hoist or lower the box suspended by the chains at will.

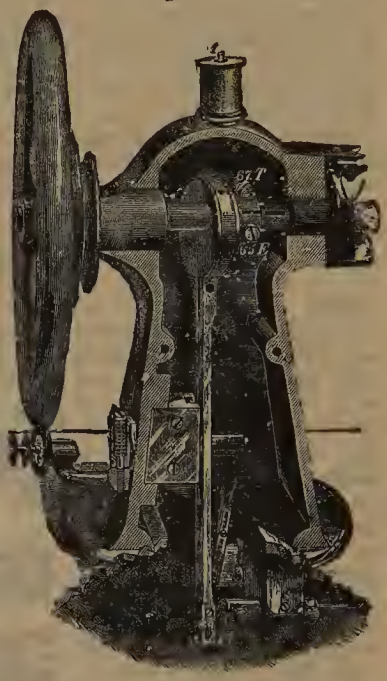
Sew'ing Ma-chine', Dress Pro-tect'or for. Mrs. E. F. Shaw's dress protector for sewing machines is a shell-shaped shield before the crank and pitman connection to keep oil from splashing upon the dress of the operator.

Sew'ing Ma-chine' Tread'le. Wilbrie & Osborn's treadle is made adjustable on the arc of a circle to adapt it to the requirements of different operators.

Sew'ing Ma-chine'. Sewing machines have arrived at that degree of perfection that in their various kinds they do about every kind of work that can be done with a needle. They are deemed almost an indispensable article in every household. See pp. 2098–2124, "*Mech. Dict.*"

Figs. 2235-2237 show the operating devices of the Wilson Oscillating Shuttle Machine, with the shuttle carrier and shuttle. An eccentric on the driver revolves the feed shaft through the vertical lever; a secondary lever, pivoted to the vertical lever midway of its length, operates the rock shaft which oscillates the shuttle; a pin on the vertical lever works in a slide to regulate the motion of the lever. An automatic cut-off in the wheel prevents the machine from running backward and allows the winding of the bobbin with the needle standing still in the work.

Fig. 2235.



Wilson Oscillating Sewing Machine.

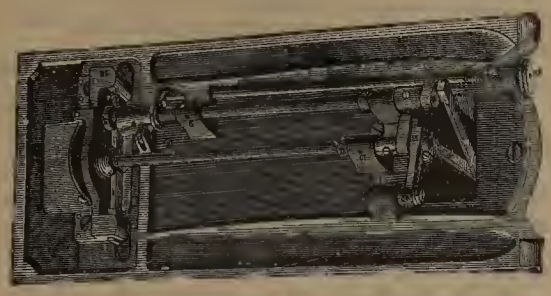
Cole's Universal Feed Sewing Machine does plain and fancy stitching, braiding, etc., stitching in any direction at the will of the operator, allowing him to follow the most intricate patterns.

An extra large machine of the Singer type, made for a manufacturing firm in Liverpool, and designed to be run by steam, weighs over four tons, and is in some respects of new design, uniting much simplicity of construction with great strength of parts. It is adapted for general manufacturing purposes of the heavier sort, although specially made for stitching cotton belting, an article which is just now taking the market as a cheap and serviceable institution for gearing and the ordinary leather belting.

The material used is of great strength and toughness, and is sewed together in plies or layers up to an inch in thickness. The belting in being sewed together is passed through heavy feed rollers some 9″ in diameter, and more than 8′ in length, getting stretched and pressed in the process. There are two needles at work with shuttles, and the shuttles can be removed from the bottom without disturbing the overlying plies or belting.

The rollers between which the work passes are actuated by reversible worm and cam motions, and the machine has, in addition to these roller feeds, what is known as a top-feed motion, suitable for a higher class of work. The stitch, as in the ordinary sewing machine, can be adjusted from one-eighth inch upward, and the pressure of the rollers on the work passing through the machine can be regulated at the will of the operator.

Fig. 2236.



Wilson Oscillating Sewing Machine.

Pitt's circular feed machine is adapted to sewing elastics in old boots, stitching round goloshes and down the fronts and backs of boots, and other repairs. The operator has control of the stitching motion, and can change the direction without stopping the machine.

Hist'y of, Centen. Rept. "*Scientific American*," xxxvi. 320.
Legat . . . . . * "*Technologiste*," xl. 70.

A consecutive account of the various operations in making sewing machines, may be found in Fairfield's "*Report Vienna Exposition*," vol. iii.

Fig. 2237.

Wilson Oscillating Sewing Machine.

G. W. Gregory's Report in Group XXII., vol. vii., "*Centennial Exhibition Reports*," gives the best history extant of the invention of the sewing machine and describes the following: —

Howe	United States.
Wheeler & Wilson	United States.
Singer	United States.
Weed	United States.
Wilson	United States.
"Domestic"	United States.
Grover & Baker	United States.
Remington	United States.
St. John	United States.
"Victor"	United States.
Whitney	United States.
"Florence"	United States.
"Lyall"	United States.
Cole	United States.
"American Button Hole, etc., Co."	United States.
Johnson, Clark & Co.	United States.
Goodes	United States.
Davis	United States.
McLean & Bennor	United States.
Wardwell	United States.
De Laney	United States.
Wilcox & Gibbs	United States.
Willis	United States.
Walters	United States.
Baker	United States.
Pearson	United States.
"United States Sewing Mach. Co."	United States.
Eickemeyer	United States.
Kimball & Morton	Scotland.
Newton, Wilson & Co.	England.
"*C. W. Williams Manufact. Co.*"	Canada.
Lawler	Canada.
Wanzer	Canada.
"Hus-qvarna Arm Manufact. Co."	Sweden.
Hedland	Sweden.
Muller	Germany.
Pollard & Schmidt	Germany.
Wilkie & Osborn	Canada.
St. Amant	Canada.
Kiehle	Germany.
Hendrickson	Denmark.
Cornely	France.
Petit	France.
Turner	Belgium.

Factory, *Wheeler & Wilson* . . . . . * "*Scientific American*," xl. 271.
Motor, electric, *Edison* "*Telegraphic Journal*," vi. 113.
Howe . . . . . * "*Telegraphic Journal*," vi. 145.
Spring, Austria . . * "*Engineer*," xlvi. 83.
Sewing machine . . . * *Fairfield's* "*Vienna Exposition Rept.*," iii.

* *Howe.*	* *Weed.*
* *Wilcox & Gibbs.*	* *Singer.*
* *Secor.*	* *Wheeler & Wilson.*
* *Wilson.*	

"Little Monitor" . * "*Scientific American*," xxxiv. 255.
Overhead, *Lang* . . * "*Scientific American.*," xxxvii. 146.
Wilson . . . . . * "*Scientific American*," xxxix. 278.
Wheeler & Wilson, No. 6 * "*Scientific American Sup.*," 853.
Treadle, Van Wyck . * "*Scientific American*," xliii. 198.
Weed . . . . . * "*Scientific American*," xlii. 175.

Sew'ing Silk. A kind of silk thread, made two-cord and twisted from left to right.

Sewing silk, manufact. of "*Scientific American Sup.*," 1958.

Sgraf-fi'to. See GRAFITO.

Shack'le. A link by which portions of objects, or lengths of chain are connected. Several types are shown in Fig. 4888, p. 2125, "*Mech. Dict.*"

Fig. 2238.

Shackles.

The term includes also hinged or jointed links, open rings, many forms of loops, lap rings, etc. Fig. 2238 shows four forms of shackle, one an open swivel hook, one a self closing hook, and the other two pulley blocks with hinged shackle fastened by a pin. See also PLATFORM SPRING.

Shack'le Flap. A manhole cover attached to the plate by a shackle.

Shack'le Jack. A clamp to compress the anti-rattling rubbers while inserting in the carriage shackles.

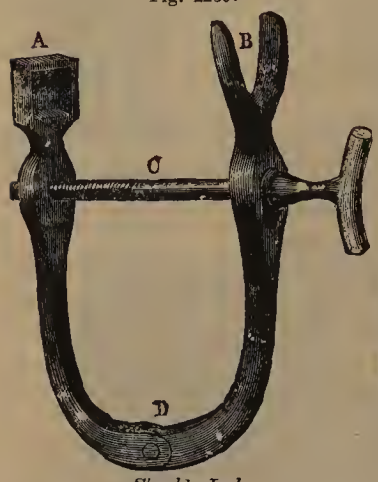
The operation of the jack shown in Fig. 2239 is as follows: Place recess *A* on the back of axle bed, yoke the fork *B* on shaft or pole eye, turn the bolt *C* until the shackle bolts can be slipped easily through the clip hole; the joint *D* accommodates itself to the bolt *C*.

Shack'le Joint. A joint for coupling together the drilling rods in boring a well.

Shade. 1. (*Glass.*) A dome, bell, or other shaped glass cover for protecting clocks, artificial flowers, etc.

They are made in a similar manner to the blown cylinder glass, the glass being kept very evenly distributed by special care and reheating.

Fig. 2239.



Shackle Jack.

Oval cylinders are blown round and then passed between two parallel pieces of wood to flatten them.

Square shades are made by four pieces of wood instead of two.

Round cylinders may be cut before

Fig. 2240.

Eye Shade.

annealing, but other forms require to be first annealed.

2. A screen attachment to a lamp to throw the light on to the book or work, and to protect the eyes from the direct rays.

Fig. 2240 shows a form of hood on a magnifying glass to protect the eye from the upper rays.

Shaft. (*Mining.*) The perpendicular, well-like excavation in mines, from which the levels are run.

Twenty years ago the deepest mining shafts in the world reached only about 2,000′ below the surface. The very deepest, we believe, was a metalliferous mine in Hanover, which has been carried down to a depth of 2,290′. The deepest perpendicular shaft to-day is the Adelbert shaft in a silver-lead mine in Prizibram, in Bohemia, which has reached a depth of 3,280′. The attainment of that depth was made the occasion of a three days' festival, and still further noticed by striking off a large number of commemorative silver medals of the value of a florin each. There is no record of the beginning of work on this mine, although its written history goes back to 1527. Quite recently an elegant commemorative volume has been written and printed, which is most interesting to those who have a taste for either the actualities or antiquities of mining industry. There are two other localities, however, where a greater depth has been reached than at the Adelbert shaft, but not in a perpendicular line. These are: 1. The Rocksalt bore-hole, near Sperenberg, not far from Berlin, which, a few years ago, had been bored to a depth of 4,175′. 2. The coal mine of Viviers Remus, in Belgium, where the miners, by shaft-sinking, together with boring, have reached a total depth of 3,542′. Turning from these two mines, no shaft, in unbroken perpendicular line, has as yet exceeded the depth of 3,280′. Taking each singly, the deepest shafts in the world at the present moment, group themselves according to the following order: —

1. The already mentioned Adelbert shaft, 3,280′ deep. As the top of this shaft is 1,732′ above the sea level, the bottom is, of course, 1,548′ below it.

2. Two shafts near Gilly, in Belgium, are sunk to a depth of 2,847′. At this depth they were both connected by a horizontal drift, from there an exploring shaft is sunk to a further depth of 666′, and from there again a trial hole, 49′ in depth, is put down, so that the total depth reached is 3,542′. As they did not, in the bore hole, discover the sought-for coal seam, they have returned to the shaft at the 2,847′ level.

3. The Eimgkerts shaft of the Lugauer coal mining company, Rhenania, Lugau, in the kingdom of Saxony, is 2,658′ deep.

4. The Sampson shaft of the Oberhartz lead and silver mining works, near St. Andreasberg, Hauover, has a depth of 2,437′, and is at present the deepest shaft of Prussian mining.

5. The winding shaft of the Rosebridge colliery, near Wigan, Lancashire, England, has a depth of 2,458′. Coal is drawn from the "hanging on" at the 2,418′ level; the time of the cage running this distance being 55 seconds; the winding rope has, therefore, an average speed of 44′ per second.

6. A shaft at the coal mines of St. Luke, near St. Chaumont, in the Loire department, France, reaches 2,253′.

7. The shaft of the Dunkirk colliery, near Dunkinfield, Lancashire, is 2,069′ deep, but the mining is prosecuted to a further depth of 755′ by shafts from the lower levels, making a total depth of the mine of 2,824′.

8. The deepest shaft of the collieries, near Ronehamp, in France, is 1,881′. A similar depth has been reached by the argentiferous mine near Kongsberg, in Norway. The mines belonging to the Roros copper works, in Norway, have worked to the depth of from 2,540 to 3,270′.

The deepest bore-hole in the world is the artesian spring at Potsdam, in Missouri, which reaches a depth of 5,500′.

The deepest coal shaft in the United States is the mammoth vein, Philadelphia and Reading Coal Co., Pottsville, Pa., 1,355′ deep.

(*Machinery.*) Screw propeller shafts are sometimes made of fluid-pressed steel and forged hollow, saving some 50 or 60 per cent. in weight.

Shaft Bolt. See Fig. 4710, p. 2063, "*Mech. Dict.*"

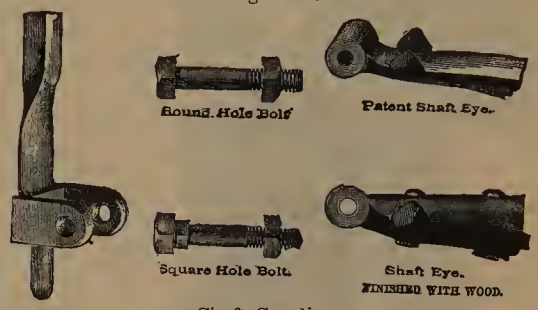
Shaft Bor′ing Ap′pa-ra′tus. See SHAFT EXCAVATOR.

Belgian . . . . . * "*Scientific American*," xxxv. 232.
Kurd-Chandson, Belgian * "*Eng. & Min. Jour.*," xxiii. 434.

Shaft Coup′ling. (*Vehicle.*) The connection formed between the thills and the clips of a buggy.

Fig. 2241 shows the clip with a straight ear, and supporting lug to hold up the shafts. The bolt may be either round or square.

Fig. 2241.



Shaft Coupling.

Fig. 2942 shows the same ear, but having a permanent pin instead of the bolt. The thill eye is made in two pieces, held and tightened on the pivot by a set screw. A rubber packing surrounds the pin to prevent rattling.

Fig. 2242.

Shaft Coupling.

See 20 examples of machinery shaft coupling, Fig. 4896, p. 2127, "*Mech. Dict.*"

12 examples thill coupling, Figs. 6380, 6381, pp. 2553, 2554, *Ibid.*

* "*Scientific American*," xxxv. 19.
Paper on . . . * "*Boston Journal of Commerce*," xx. 171.

Shaft Ex′ca-va′tor. A system of apparatus designed for sinking the shafts in coal mines.

The machines are of colossal size and form, the most prominent feature of the vicinity. A trepan weighing 15 tons, is made of forged iron, and fitted with cutters secured by taper keys, so as to make a cut 6′ long. The trepan is raised by steam power to a height of 3′, and dropped. It is turned at each elevation so that a circle 6′ in diameter is cut. The advance in soft sandstone is said to be 3′ per day. The trepan being withdrawn, a massive iron bucket is fitted into the hole to remove the *débris*. After the first tool has penetrated about 30′, a second trepan, much heavier than the first and having a central guide working in the opening made by the first, is used, and, in the stone above mentioned,

it progresses at the rate of about a foot per day. A grapple for recovering broken rods, and a sweep to catch the sections of lifting bars, are also used. There is, besides, a grapple for stones, etc., which is an ingeniously constructed pair of double lazy tongs arranged so that the arms extend to the sides of the hole as the device is being lowered, and scour the bottom as it is being lifted.

When the cutting is finished, circular plates are let into the opening, the bottom plates or cylinder sliding inside of a second ring, and being surrounded with a moss gasket compressed between the flanges. This keeps the water out of the bottom. The second ring is convex beneath and floats on the accumulated water. Then, as ring after ring is added, the water is allowed to escape, the rings sinking gradually. Guides prevent the casing from tilting until it is secured to hard impervious strata, when the shaft is pumped out and is then ready for use.

Shaft-sinking, Belgian system . . "*Van Nostrand's Mag.*," xxiii. 504.

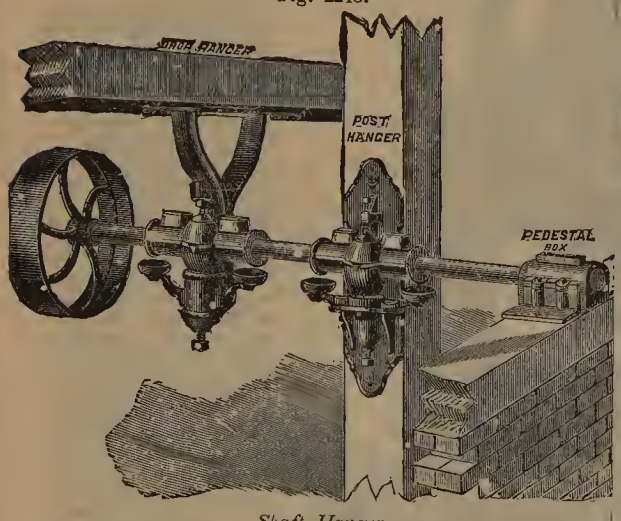
Shaft Eye. The hole in the end of a thill or recess or hole in other shafting through which the coupling pin or key passes.

Shaft Fur'nace. (*Metallurgy.*) The *stücköfen* or *Wolföfen* of Styria was considered the first representative of the high furnace, and the progenitor of the modern *blast* furnace for cast iron. The iron from a single turn of the furnace was taken away in a mass (*stück* or *wolf*) at an opening made at the hearth, and weighed from 1,000 to 1,400 pounds. Some fluid carburized iron ran out, and here the cast-iron continuous process, doubtless, had its commencement, or suggestion. Such furnaces, shaped like two cones joined at their bases, and from 10′ to 16′ high, were common in Styria in the seventeenth century. In 1760 the *flossöfen* was introduced; it was 25′ high, and produced cast iron by continuous process. The *blanöfen* succeeded it, and two tapping tools, for iron and slag respectively.

Shaft Hang'er. A swinging or stationary bracket to support the shaft.

The drop hanger in Fig. 2240 is adjustable, vertically and horizontally, and self-adjusting to any angle, the box working in a socket, and is self-lubricating. The post hanger is also self-adjusting to any angle, and is adjustable ver-

Fig. 2243.



Shaft Hanger.

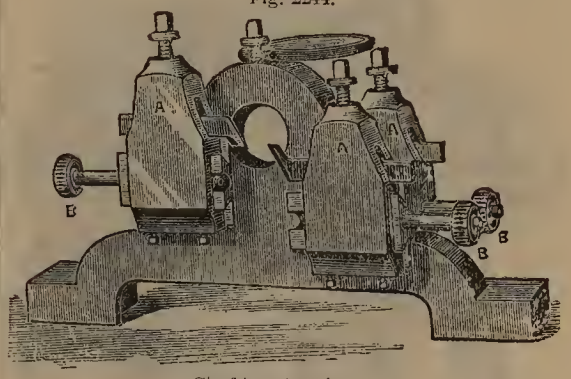
tically and horizontally, the box being moved to or from the post by means of check bolts, without disturbing the plate of the hanger, which is bolted to the post or timber. It also has the improved lubricating box, and both hangers are neat and ornamental in design.

Shafting cup . . . . "*Scientific Amer.*," xxxix. 100.
Hanger . . . . . * "*Mech. Dict.*," p. 1059.
* "*Mech. Dict.*," Figs. 4899, 4901, p. 2129.
Ball and Socket . . * "*Engineer*," xlii. 61.
Bancroft . . . . . *Thurston's* "*Vienna Rept.*," ii. 215.
Shafting adjusting line * "*Scientific American*," xxxvi. 24.

Shaft'ing At-tach'ment. An adjunct to a lathe used especially in turning shafting.

It consists of a heavy arch piece bolted on to the rest, carrying three turning tools, two on the front and one on the back of shaft, and having a hole bored out in the upper part

Fig. 2244.



Shafting Attachment.

of arch to receive bushes for steadying the shaft while turning, or to hold fluted rings for finishing the shaft. The first tool on the front takes off the first chip, and the tool on the back turns the shaft to its proper size. After it passes through the bush the water polishing tool finishes the shaft, leaving it perfectly round and smooth. Each tool is adjusted by a separate screw operating the tool block that carries it. (See Fig. 2244.)

Shaft'ing Lu'bri-ca'tor. A device for supplying oil to a bearing in which a shaft rotates.

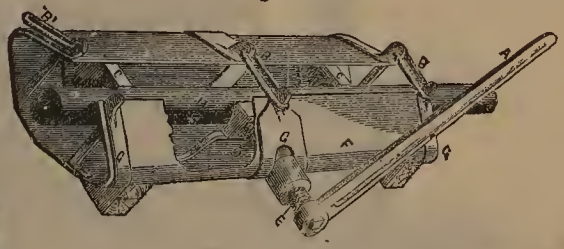
See LUBRICATOR, OILER, SELF-OILING BEARING, *supra.*

Shaft Rub'ber. An anti-rattler. One form is a rubber block with a concave face to fit round the end of the shaft, and hold it in place. See Fig. 4889, p. 2125, "*Mech. Dict.*," and SHACKLE JACK.

Shaft Straight'en-er. Straightening device or bender for shafting, axles, tubes, rails, etc.

The accompanying cut, Fig. 2245, represents a wrought iron frame bound by the bands *G*. These are held together by the liuks *B* when the machine is being operated, and are throwu back, as shown at *B′*, when the work is to be in-

Fig. 2245.



Shaft Straightener.

serted or taken out. The shaft *H* to be straightened rests against the two movable dogs *C*, and the dog *D* is brought to bear upon the middle and opposite side, then by turning the screw *E* by means of the lever *A*, the shaft *H* may be crooked to any extent.

Shaft Tip. The ferrule at the end of a carriage shaft.

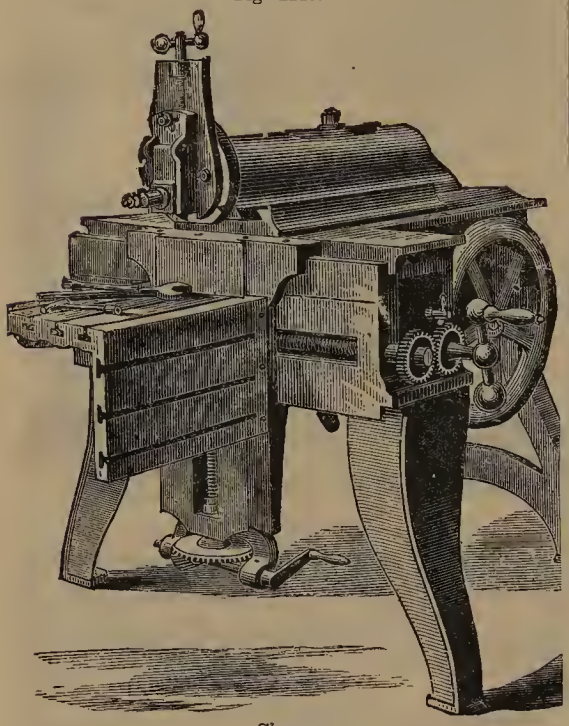
Sha-green′. Hard, colored, metallic spots found on the surface of iron castings; probably produced from the pellets or small spherules found in cavities in pig iron. The analysis of the *pellets* and *shagreen* is similar, showing abundant phosphorus and carbon, and diminished silicon and graphite.

Shank Spring. A spring steel piece to unite the sole and heel of a boot, giving an elastic support to the arch.

Sha'per. A combined lathe and planer.

Fig. 2246 shows Hill, Clark & Co.'s shaper with a 12″

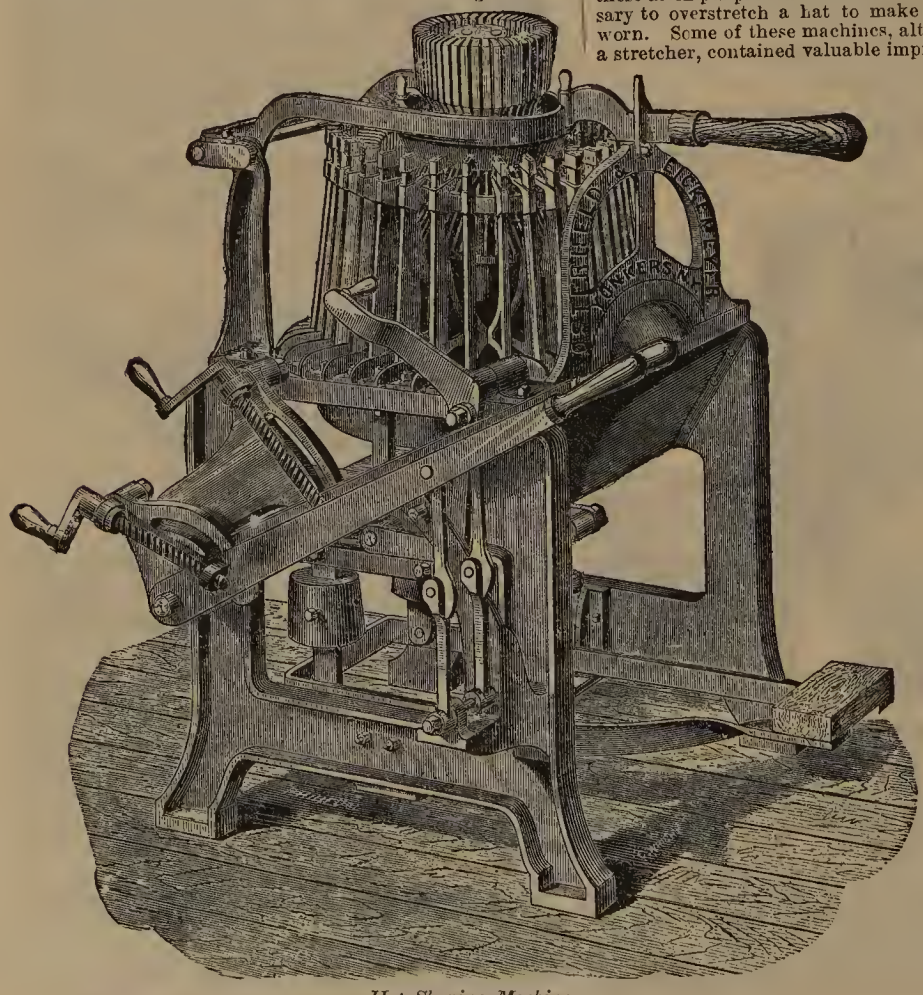
Fig 2246.



Shaper.

stroke, 22″ cross traverse of table, Whitworth quick return, and rotary planing attachment with self feed.

Fig. 2247.



Hat Shaping Machine.

Manville	* "*Scientific Amer.*," xxxviii. 358.
	* "*Manuf. & Builder*," viii. 30.
Pratt & Whitney	* *Thurston's* "*Vienna Rept.*," ii. 221.
Sharpe, Stewart & Co., Br.	* "*Engineering*," xxvii. 444.
Collier & Co., Br.	* "*Engineering*," xxiii. 314.
	* "*Scientific American Sup.*," 1185.
MacCord	* "*Scientific American Sup.*," 248.
Ferris & Miles	* "*Iron Age*," xx., Sept. 20, p. 1.
And molding machine, (wood), *Richards*	* "*Engineering*," xxiii. 489.

Sha'per Plate. A pattern plate in a lathe, for instance, which governs the cut of the tool.

Such are found in gun-stock, last, and baluster lathes, etc.

Sha'per Vise. One adapted to hold work to a planer, at any horizontal angle.

In Newell's design the vise turns on a graduated base, so the work may be adjusted at any horizontal angle. One of the jaws is V-shaped for holding circular pieces, and swivels to present either that or the straight face. The actuating screw is protected from chips and dirt and the jaws are faced with hardened steel.

Sha'ping Ma-chine'. To complete the operation of blocking fur hats, after the tips and brims have been stretched on special and separate machines, a finishing blocking machine is employed.

This is represented in Fig. 2247, the invention of R. Eickemeyer.

To block a fur hat it is necessary to bring it much nearer to the size and shape of the finished hat than is necessary in the case of a wool hat, which is more elastic and can be more readily shaped when put on the finishing block, and it is therefore necessary to use blocks and rings of the right oval to shape fur hats.

Many attempts were made to construct machines to block or shape fur hats without previous stretching, but all of these attempts proved failures because it is absolutely necessary to overstretch a hat to make it retain its shape when worn. Some of these machines, although of no use without a stretcher, contained valuable improvements. The first important change was the substitution of tongs to clamp the hat brim in combination with the banding ring and block, in place of the clamping plates, banding ring, and block in the wool hat blocking machine, and this improvement was patented February 26 1867, by Joseph De la Mar, of Brooklyn, N. Y. W. H. Behrens and Jacob Surerus, of Newark, N. J., patented, May 3, 1870, a machine in which an out-stretching motion was given to the brim tongs, thus adding another desirable feature to the machine. All the improvements of former machines are embodied in the present machine and such others added as were suggested by the experience in its use for a number of years. The hat block, which is composed of 48 pieces, and can expand from 6″ to 8″ average diameter, is in this manner adjustable for all the usual sizes of hats. 36 tongs grip the edge of the brim, taking hold about 3-8 of an inch of the hat body. The tongs being movable to and from the center of the hat block are arranged equidistant around the oval banding ring and the brim is thus drawn out, of equal width all around. The height of the block can be varied between 2½″

and 7″, while the brim tongs have a range of from 2″ to 5½″ of the width of brim.

To shape a hat, or more properly to develop the band, the hat body, the tip and brim being previously stretched, is well soaked in hot water and is then put on the block. The latter has been previously contracted to its smallest diameter and the tongs are resting close to the block. The operator now puts his foot on the treadle and spreads the tongs until the brim slips off the loose jaws and rests upon the lower jaws, when he allows the tongs to close up to the edge of the brim. The loose tongs are now closed upon the edge by a turn of the short hand lever on the left side of the machine. The hand lever to which the handing ring is attached is thrown over the block and fastened by the hook in front of the machine.

The hat brim is now firmly held by the tongs, the operator raises the block by the outer hand lever, and, while depressing the treadle by his foot, spreads out the block to the desired size. The hat is then cooled and taken off, and the operation repeated on the next hat.

Four to six dozen can be readily blocked per hour by a good operator, and, as all the adjustments, — namely, the the size of band, height and diameter of crown, and width of brim, — are made by gages attached to the different levers, the operator can set each part in a few moments.

All sizes of hats from the largest to the smallest can be blocked on the same machine.

Share.

Fig. 2248.

European Plow Shares.

A. Square work. *Labour rectangulaire.*
B. Crested work. *Labour trapézoidal.*
C. Stony land. *Terres pierreuses.*
D. Deep land. *Labour profond.*
E. Wide work. *Large labour.*
F. Paring. *Déchaumer.*
G. Setting-out. *Traçage.*
H. Ridging. *Billonnage.*
I. Subsoiling. *Sous-sol.*
J. Skim colter. *Couteau.*

Shares Har'row. One having shares instead of the ordinary teeth.

Shar'py. (*Fishing.*) Local. A long, sharp, flat-bottomed sail-boat.

Shav'ing. (*Leather.*) In this operation the currier's knife is driven from the top to the bottom of the beam, thus taking off shaving after shaving, removing all the inequalities left after skiving, and making the leather of uniform thickness, also leaving a beautiful smooth face on the flesh side. This operation is sometimes called *flattening.* The shaving or flattening is done almost at right angles to the skiving.

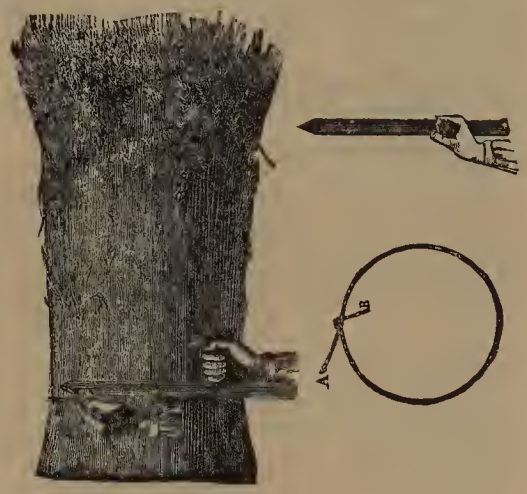
Shav'ing Ma-chine'. (*Stereotyping.*) Hand-machine for shaving stereotype plates, Fig. 5795, p. 2379, "*Mech. Dict.*" Power machines for the same purpose, p. 125, * R. Hoe & Co.'s catalogue, edition 1881.

For shaving hats, in the finishing process. See POUNCING MACHINE, *supra.*

Sheaf Bind'er. A hand implement for binding the sheaf with cord.

Fig. 2249 shows a French hand-binder. The string is strained around the sheaf by means of the stick. The band is composed of two cords knotted together, forming loops. The point of the tool is introduced through a loop at or near one end, and is thrust as far as the handle permits. The band being placed around the sheaf, the point of the tool is thrust through such one of the other loops as will give the tightness to the band, and the handle end of the tool is then carried over, describing an arc upon the point which is in the sheaf; the loop slips down from the handle to the point end,

Fig. 2249.



Sheaf Binder.

and the loop caught in the notch is then drawn through the loop on the stick, and the latter is withdrawn, allowing the knot drawn through to catch in the loop, where it is held by the expansion of the sheaf. The cords are 5′ long.

At the Paris Exposition were shown various attempts to obviate the use of the bunch of straw taken from the sheaf to form a band. One man proposes to use the bark peeled from osiers, two or three twisted together; these are sold very cheap. Another has cheap hempen strings cut to length and sold in bundles of one thousand each.

It is estimated that the annual crop of France is about 4,000,000,000 sheaves of grain, and that 50 straw bands contain one franc's worth of grain, the whole representing 80,000,000 fr., most of which is lost by shelling out on to the ground or mildewing under the band. Add to this the loss of time in making and applying, and the injury to the grain in the size of the band, which causes dampness to the sheaf. The figures seem formidable, and the *automatique* band is presented to solve the difficulty. The estimate is French, and in the interest of the hempen-band sellers; it is probably somewhat exaggerated.

Fig. 2250 shows a grain-band having a string attached to a block, and after passing around the sheaf rove through a ring. The mode of using it is evident from the engraving; the wooden block being held in one hand, one knee of the operator is placed upon the sheaf to compress it, while the other hand draws the cord through the ring. The expansion of the sheaf pinches the cord between the ring and the block, and makes a perfectly tight fastening. The cord and block are treated with tar, and are smoked to render them indestructible by humidity and noxious to insects, rats, and lizards.

Fig. 2250.

Sheaf Binder.

See BINDING REAPER and SHELF BINDER, *supra,* and REAPER, "*Mech. Dict.*," pp. 1889-1898.

Sheaf band cutter, *Wood* * "*Engineering,*" xxv. 182.
Sheaf binder, *Burgess,* Br.* "*Engineering,*" xxviii. 28.
Landelle, Engl. . . * "*Scientific Amer.,*" xxxix. 146.
Toulousain, Fr. . . * "*Scientific Amer.,*" xxxix. 179.
Wood . . . . . * "*Engineering,*" xxv. 182.
* "*Engineering,*" xxi. 68.

See also BINDING REAPER.

Shear'ing Ma-chine'. Apparatus for cutting by power.

Shears . . . . . * "*Scientific Amer.,*" xxxiv. 132.
Hydraulic Shears, Toulon Arsenal . . . * "*Engineer,*" xli. 208.
Tweddell, Br. . . . * "*Engineer,*" xliv. 98.
* "*Scientific American Sup.,*" 352.

Cardboard, Figs. 539-541, p. 166, *supra.*
Sheep. See Figs. 4942, 4946-4951, p. 2140, "*Mech. Dict.*"

Surgical. See SCISSORS, Figs. 4671, 4672, p. 2054, "*Mech. Dict.*," *et supra*.
See also BAR SHEAR.
PLATE SHEARING MACHINE, Fig. 1962, p. 691, *supra*
PUNCH AND SHEAR.
Shearing machine bar.
Collier . . . . . * "*Scientific American Sup.*," 467.
Heavy, *Collier*, Br. . * "*Engineering*," xxi. 477.
Plate, *Sellers* . . . * "*Scientific American*," xli. 259.
Shearing & punching machine, hydr., *Tweddell* * "*Engineering*," xxvi. 270.
Double, *Wagner* . . * "*Sc. American*," xxxviii. 163.
Shearing, punching and straightening machine.
Wagner, Ger. . . . * "*Engineering*," xxiv. 489.

Shears. (*Glass.*) The scissors of the glass-blower to remove superfluous parts of the viscous glass under treatment, such as cutting of the irregular margin of the mouth of the goblet, etc.

Shears, Scis'sors, etc. See under the following heads: —

Bent trimmer.
Candy shears.
Cartilage scissors.
Clippers.
Cutting nippers.
Flower gatherer.
Fluter.
Fluting scissors.
Horse clipper.
Lateral scissors.
Pruning shears.
Revolving scissors.
Sardine shears.
Scissors.
Seizing scissors.
Shearer.
Snap.
Surgical scissors.
Tenaculum scissors.
Tinner's snips.
Trimmer.
Vine shear.
Vivifying scissors.

Shears, Double, *Laws* . * "*Sc. American*," xxxviii. 134.
Iron, *Cleveland Hardware Co.* . . . . * "*Iron Age*," xxi., May 2, p. 25.
Power, *Pratt & Whitney* * "*Manufact. & Builder*," xii. 16.
Pratt . . . . . * "*Am. Man.*," August, 1879, p. 16.
Stiles . . . . . * "*Iron Age*," xxiii., Jan. 16, p. 5.
For brass, Hydraulic.
Tweddell, Br. . . * "*Engineering*," xxvii. 67.

Sheath Knife. The fisherman's knife, worn in a sheath.

Sheer Boom. (*Hydraulic Engineering.*) The word is taken from the sheer boom for logs, used by lumbermen, p. 2141, "*Mech. Dict.*"

A floating structure moored aslant in a stream to direct the current in a given direction to prevent erosion on a certain shore, for instance. Such a boom 750′ in length and furnished with 44 rudders, 20′ long and 16′ apart, is operated by wire ropes and crabs near Rock Island, Ill. See "*Report of Chief of Engineers, U. S. Army*," 1878, * ii. 710.

Anderson's booms are designed for gathering and storing away in an inclosure logs floating down with the current of a river; and the nature of the invention consists in combining, with a sheer-boom adapted to float upon the surface of the water, and to be pivoted to a pier-head, a number of horizontally-vibrating fins or blades pivoted to the said boom, whereby they are adapted to be vibrated outward for the purpose of utilizing the force of the current for placing the sheer-boom in position for work, or inward toward the said boom, for the purpose of causing it to swing down stream out of the way when not in use, or to allow the passage of steamers or other vessels in navigable rivers.

Sheer Pole. One of the spars of a sheer, or a single one with guys and used as a substitute for regular sheers.

Sheet Cal'en-der. A machine for pressing paper, rubber, etc., into sheets and giving it surface. See CALENDERING MACHINE, *supra*.

Sheet De-liv'e-ry. Delivering the printed sheet from the form to the fly.

Cottrell's air sheet delivery floats the freshly printed sheet down the gages, without the use of tapes, to avoid the blurring or smutting sometimes produced by these.

Two pipes leading from the hollow pistou of the air-plunger, one conveys the air to the governor, and the other to an air receiving cylinder located under the track. The air in this receiving-cylinder is permanently kept at the highest pressure, which is attained by a check valve in the pipe leading to it. From the air cyliuder is an upright pipe connecting with the perforated tubes. In the upright pipe is a trip-valve, operated by a cam, which opens the valve at the precise instant the sheet comes over the wheels, inducing a puff of air sufficient to carry it down to the gages on the fly, and without touching the fingers.

The exact amount of air required to float the sheet can be regulated instantaneously by the pressman, so that the printed sheet is always under perfect control.

The Adams press uses a bellows for same purpose.

Sheet-i'ron Work.

See *Blinn's* "*Practical Workshop Companion for Tin, Sheet-iron, and Copper-plate Workers.*"
Perkins & Stowe's "*A New Guide to the Sheet-iron and Boiler Plate Roller.*"

Sheet iron, thin . . . "*Scientific Amer.*," xxxiv. 356.
Russian . . . . . "*Eng. & Min. Jour.*," xxvi. 199.
"*Scientific American Sup.*," 2449.
"*Iron Age*," xvii., Jan. 20, p. 1.

Sheet Lead. Lead made in sheets by hammering or casting.

The making of sheet lead for the lining of tea chests, etc., is a somewhat important industry of Hong Kong. It is made principally in sundry establishments to the westward. On entering one, workmen will be seen with shears busily employed in cutting out the sheets of lead into the required sizes and shapes. The shears are simply a large pair of scissors, firmly fixed to a solid block of wood some 2′ in height. The lower blade of the shears terminates in a square piece of iron instead of being pointed, as is the upper blade. The sheets of lead will also be observed to be of small size and somewhat irregular in shape, and this arises from the method of manufacture, as will subsequently be seen. Going further into the shop will be seen an iron pan raised 12″ or so above the ground and carefully finished off. Beneath this iron pan is a furnace, and at the side of the pan next the wall is the flue communicating with it. In this pan the lead is melted, and when judged to be hot enough, the workman takes two of the large square paving tiles, which may be seen almost anywhere in the colony, and these are then smoothly and carefully covered with several layers of unsized paper. Having placed these two tiles before him, one above the other, the workman raises the upper tile with his left hand, and, taking a ladle of the proper size in his right, he dips it in the melted lead and then pours its contents on to the lower tile. He then drops the upper tile and quickly presses the lead out into the form of a sheet. The paper being a bad conductor of heat, the lead does not solidify immediately it leaves the ladle, and, as by long practice the workman always ladles out exactly the same quantity of lead, the sheets made vary but little either in size or thickness.

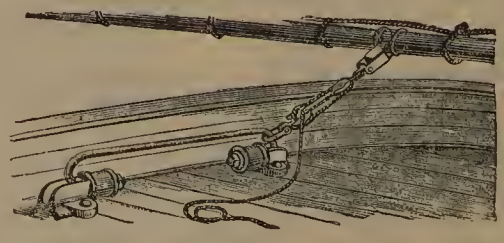
"*Scientific American*," xlii. 341.
Sheet lead & pipe man. * "*Scientific American*," xxxvii. 30.
Sheet lead rolling mill . "*Manufact. & Builder*," ix. 172.

Sheet Point'ing Ma-chine'. A machine for preparing printing sheets for cutting. The needles which project above the surface of the table are adjustable to suit the perforations made by points in process of printing. When a sufficient number of sheets are placed the points are drawn down, leaving the paper accurately piled and ready for the cutting machine.

Page 160, *R. Hoe & Co.'s Catalogue, ed. 1881.

Sheet Trav'el-er. (*Nautical.*) A grommet punched from sheet metal, adapted to slide on a spar, rope, bowsprit, etc.

Fig. 2251



Sheet Traveler.

Shelf' piece. (*Nautical.*) A strake of plank running internally in a line with the decks to receive the ends of the beams.

Shell. 1. (*Nautical.*) The body of a tackle-block. The groove outside is the *score*. The space occupied by the *shears* is the *swallow*.

2. A metallic or paper cylinder, inclosing a cartridge.

Shell truck . . . . * "*Scientific American Sup.*," 514.

3. A Russian tool for turning insides of hollow projectiles. Fig. 26 accompanying Appendix I., "*Ordnance Report*," 1877, and page 528.

Shell Piece. (*Spectacles.*) One of the shields of tortoise-shell or horn, used with spring eye-glasses which clasp the nose.

Shell Re-du'cer. A device for reducing or expanding a cartridge shell.

The instrument is held in the right hand, open far enough to allow the shell to be entered sideways into its seat, catching the flange under a hook in a top piece and entering the open end of the shell into a die. The handles are then pressed together to reduce the shell at the mouth. By opening the handles the shell will be withdrawn from the die; and as it then may be a little too small it can be brought to the exact size of the bullet by the repetition of the same process, using a plug instead of the die.

Shift'ing Lo-co-mo'tive. A yard locomotive. See SWITCHING LOCOMOTIVE.

Shin'gle Ma-chine'. Burt's 12-Block Rotary Shingle Machine has an iron frame carrying two horizontal circular saws at opposite sides of the iron frame, above which, mounted on rollers and revolving above the saws, is a circular carriage divided by radial ribs or arms into 12 sectors of varying widths. At the inner end of each sector is a dog which advances and retreats in the horizontal plane twice in each revolution; this being effected by belt crank levers and inclined planes. A block being placed in a sector at a point midway between the saws, the dog holds it; and the table, revolving, carries the block to the saw, which cuts a shingle off the bottom; the dog then loosens the block and allows it to drop, again gripping it just in readiness for the next saw. The 12 sectors may all be filled at once, two shingles from each being cut at each revolution (or 24 in all).

The shingles may have any desired taper, and may be either 16 or 18 inches long. The capacity of the machine is stated at 200,000 white pine or cypress shingles per day, 30 horse power driving the machine, drag saw, jointer, bolter, etc.

Shingle cutting machine.
Trevor & Co. . . . * "*Scientific American*," xli. 22.
Shingle machine, *Burt* . * "*Engineer*," xli. 430.
Metallic . . . . . * "*Iron Age*," xxii., Sept. 5, p. 5
* "*Man. & Builder*," xi. 31; xii. 269.
Shingle sawing machine.
Trevor & Co. . . . * "*Scientific American*," xli. 22.

Ship. A sea-going vessel; especially a three-masted square-rigged one.

Fairbairn, Wm. "*Treatise on Iron Shipbuilding, its History and Progress.*"
Fincham, J. "*An Outline of Shipbuilding.*" In four parts. Part I. Method of Constructing the Body, and instructions for Making Calculations; with Examples. — Part II. On the Actual Building of Ships. — Part III. On the Principal Materials used in Ship-Building. — Part IV. A Vocabulary of Terms.
Grantham, J. "*Iron Shipbuilding.*" 5th edition. London, 1868. (Weale's series.)
Marett, P. R. "*Yachts and Yacht Building.*" Being a treatise on the construction of yachts and matters relating to yachting. 2d edition. London, 1872.
Meade, Com. Richard W., U. S. N. "*A Treatise on Naval Architecture and Ship-Building, or an Exposition of the Elementary Principles involved in the Science and Practice of Naval Construction.*" Compiled from various standard authorities. Philadelphia, 1869.
Murray. "*Ship-Building in Iron and Wood*," by Andrew Murray, and "*Steamships*," by R. Murray.
Nystrom, N. W. "*On Technological Education and Ship-Building, for Marine Engineers.*"
Nystrom, N. W. "*A Treatise on Parabolical Construction of Ships and other Marine Engineering Subjects.*
Peake, J. "*Naval Architecture.*" (Weale's series.)
Reed, E. J., C. B. "*Our Iron-Clad Ships; their Qualities, Performances, and Cost. With Chapters on Turret Ships, Iron Clad Rams*," etc. London, 1869.
Smith, Thomas, M. J. N. A. "*The Hand-Book of Iron Ship Building.*" London, 1869.
Sommerfeldt, H. A. "*Elementary and Practical Principles of the Construction of Ships for Ocean and River Service.*" (Weale's series.)

Ship, arrangement of machinery, in sloops . * "*Scientific American Sup.*," 900.
A Viking's, "*Architect*" "*Van Nostr. Mag.*," xxiii. 320.
Cord, self-trimming, Engl. . . . . * "*Scientific American Sup.*," 1157.
Despatch, "Iris," Engl. "*Scientific American Sup.*," 1728.
"Hussar" . . . . "*Scientific American Sup.*," 493.
"Inflexible" and her armament . . . . * "*Scientific American Sup.*," 122.
"Iris," Engl. . . . "*Scientific American Sup.*," 1921.
Raising apparatus, "Edith," Br. . . * "*Engineer*," xlv. 254.
Railway, *Eads* . . . "*Scientific American*," xlii. 192.
Keiffer . . . . . "*Iron Age*," xxiv., Aug. 14, p. 7.
Flad . . . . . * "*Railroad Gazette*," xxiii. 429, 469.
Steel, "Comus" . . * "*Scientific American Sup.*," 2841.
Speed indicator. *Normanville*, Engl. * "*Scientific Amer.*," xxxvii. 259.
Solid timber war- . . * "*Iron Age*," xxi., Jan. 3. p. 16.
Shipbuilding, Clyde . . "*Scientific American Sup.*," 951.
Steel (Clyde) . . . . * "*Scientific Amer.*," xxxvi. 85.
London "*Times*" . "*Scientific American Sup.*," 1144.
Steam, "Vera Cruz" * "*Scientific American Sup.*," 870.
Ships of the World, merchant . . . . . "*Scientific American Sup.*," 1992.
War, of Europe . . "*Scientific American Sup.*," 1729.
War, report by Chief Engr. King, U. S. N. 1877.
Cellular system for. *Boolds* . . . . . * "*Scientific American Sup.*," 362, 363.
Boold, Br. . . . * "*Engineer*," xli. 246.
Compartment, merchant and navy. *Thompson*, Engl. . * "*Scientific American Sup.*," 2000.
Japanese war, "Foo-So," "Kong-go" . * "*Scientific American Sup.*," 1677.
Longitudinal girder and bulkheads. *De Russett* . . . * "*Engineer*," xli 311.
Multifold shells. *Egerton*, Br. . . . "*Engineer*," xli. 265.
Of British Navy, table of data . . . . . * "*Engineering*," xxv. 224.
Ship's Lines, *Jackson* . * "*Sc. American Sup.*," 1231, 1523.
Shipping of the world . "*Scientific American Sup.*," 1633.

Ship Float. 1. A lighter.
2. The splashers of a paddle-wheel.

* "*Engineering*" . . . . . xxiii. 369-371.

Ship Rail'way. A railway composed of several tracks, with a carrying cradle for transporting small coal-laden vessels overland from one body of water to another.

Capt. J. B. Eads's plan of a proposed ship railway across the isthmus of Panama consists essentially of a series of some eight or ten tracks, having a carrying car or cradle consisting of some five sections. These to have 1,000 wheels. Estimating the weight of a large merchant ship and cargo at 10,000 tons, and distributing it over an area of $40 \times 500'$ would give a pressure on the road-bed of about 1,200 pounds per square foot, cars and all, not half the pressure on the earth under each tie as there is when the driving-wheels of an ordinary locomotive pass over it. A ship railway across this isthmus has been the subject of much discussion, for more than thirty years, in fact.

Eads, "*Scientific American*," xli. 64, 68, 97, 144, 160; xliii. 303.

Ship Scra'per. A triangular or square piece of steel, handled, and with sharpened edges for scraping the keels and decks of vessels. See SCRAPER, "*Mech. Dict.*"

Ship's Tim'ber Saw. A machine for giving the proper lines to ships' timbers. See BEVEL SCROLL SAW, Fig. 669, p. 279, "*Mech. Dict.*," and SAWS, *Ibid.*

Shirt Frame. A Guernsey, or shirt knitting machine.

Shod'dy Ma-chine'. See RAG PICKER.

Shoe Bolt. One with a countersunk head for cutter and sleigh runners.

Shoe Em-boss'ing Ma-chine'. For embossing the vamps of boots. The stamp is heated by steam or lamp, and the boot, which is held on a goose-neck, is forced up against the die by a treadle.

Shoe-ma'ker's Wax. A wax used in making the waxed ends used in sewing leather.

Shoemaker's wax, when made for hand-work, is composed generally of equal quantities of pitch and resin, with 10 per cent. of tallow; after boiling (if good wax), it is pulled until the wax assumes the color of pale resin. The pulling takes out, or, more properly, bleaches, the ingredient pitch, and thereby takes out the coloring all pitch contains. Wax used for machines has all of it too much pitch and tar for clean work; the coloring matter in pitch and tar comes up through the grain; once in it cannot be got out — and wax boiled or heated again, unless in a perfectly clean vessel, and even then, partly recovers the coloring bleached out by hand-pulling. Wax that will work up the pure bronze color so much liked by shoemakers may be made of 4 lbs. resin, 1 lb. pitch, 4 oz. beeswax, 3 oz. tallow — the tallow to be refined, otherwise 3 oz. best sperm oil. The beeswax seems to destroy the coloring matter of the pitch when in that proportion. A good resin wax is superior to any other composition for wear, because it decomposes on exposure and wear into a stony substance in appearance, and looks not unlike pegs of amber when put under the microscope. Wax, with tar at all in, or much pitch, when heated continuously, becomes only a dirty discoloring matter, as the oil evaporates, carrying with it all the valuable adhesive or glutinous properties of the pitch, and such wax will most readily soil or discolor the flange of the channel that is laid over it. The above recipe makes a wax which will give satisfaction.

Shoe Pad. A cushion to lessen the shock on a horse's foot.

Shoe Peg'ging Ma-chine'. A machine which takes the pegs in the strip, feeds and cuts them, and pegs on the sole. The preparatory machinery, in getting out the pegs from the log, consists of the slabber, heading machine, boring machine, pointer, splitter, bleacher, fan-blower, steam dryer, polisher, separator, winnower. See PEGGING MACHINE, *supra*.

Shoe Sew'ing. A sewing-machine having a thread-carrying hook in the end of a horn small enough to be inserted inside of the shoe at all points. The hook, acting in conjunction with the needle, sews the sole to the upper with remarkable celerity. See "*Mech. Dict.*," pp. 2162, 2163.

Shoe Sol'ing. Fastening the soles to the uppers by machinery. See "*Mech. Dict.*," pp. 462, 463, and PEGGING, *supra*.

Short'-cheek Bri'dle. A blind bridle having short cheek-pieces with rings at the lower ends, into which the bit-strap is buckled.

Short Cir'cuit. (*Electricity.*) The completion of a circuit by a shorter route or cross-way.

Short'en-ing Knot. (*Nautical.*) A form of knot shown at 40, 41, Fig. 2777, p. 1240, "*Mech. Dict.*"

Short'hair Knife. (*Leather.*) A keen-edged knife used in the beam-house to remove short hairs (new growth) from the hides.

Short Splice. (*Nautical.*) The junction of two ropes intertwining the strands for a relatively short distance. See *i*, Fig. 5435; also *a*, *b*, *c*, Fig. 5434, p. 2279, "*Mech. Dict.*"

Short Stay. (*Nautical.*) In weighing anchor, it refers to the position of the anchor when nearly under foot in heaving in.

Shot Com-press'or. (*Surgical.*) A forceps to fasten leaden shot upon the ends of a ligature as a substitute for tying. The shot is partially split with a knife, put over the ligature threads close up to the suture, and the shot pinch-closed upon them.

Shot Gun. Fig. 2252 is a breech loading shot gun manufactured at Colt's armory. The parts are interchangeable, and so accurately made that parts of different guns may be intermixed and a gun may be put together from parts taken haphazard. The lock is of the rebounding style, and the firing pins are without springs.

The action bolt which retains the barrel in its place is moved by a lever, back of the hammer, through the medium of internal parts not shown in the engraving. This bolt en-

Fig. 2252.

Colt's Breech Loading Shot Gun.

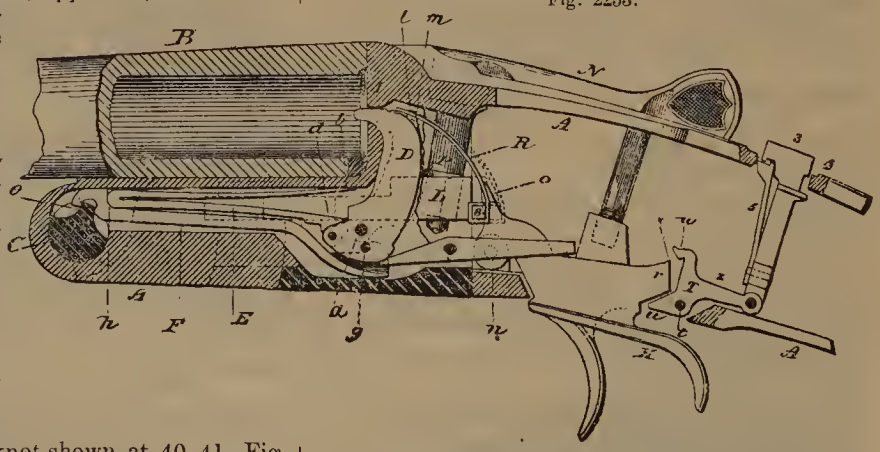
gages two hooks on the barrels and retains the barrels rigidly in place.

The bolt carrying the shell extractors is engaged by a cam on the bolt, connecting the stock and the barrel, and when the barrel is released by drawing the action bolt and tipped as shown in Fig. 2252, the shell extractor is operated.

Fig. 2253 shows that form of the Colt shot gun, having concealed hammers which are cocked by the *breaking down* of the barrels. The hammers can be locked in this position, to prevent accidents, by a forward motion of the trigger, and released at will by a forward and downward motion of a stop on top of the stock.

The shield or shell-shaped piece formerly placed upon the

Fig. 2253.



Colt's Concealed Hammer Breech Loader.

breech piece of muzzle-loading guns to prevent particles of the cap from being blown into the eye has been entirely dispensed with upon the Colt gun. It was a curious instance of the persistence of a form after its use has entirely departed.

Colt . . . . . * "*Scientific American*," xlii. 342.

Shot Line. (*Life Saving Apparatus.*) The cord attached to a projectile fired from a piece to fall over a wreck or stranded vessel and thus establish communication between ship and shore.

See pp. 200 and 251, "*Ordnance Report*," 1878, Appendix P.

Braided linen lines, Nos. 3½ to 7, are preferred.

Shroud Knot. (*Nautical.*) A form of knot shown at 48, Fig. 2777, p. 1240, "*Mech. Dict.*"

The shroud knot is a species of splice that, instead of lying smoothly, stands out boldly in an even, well-shaped knot. To make it, unlay the ends of the rope for a couple of feet or so, and then interlace them; then make a single wall-knot with the ends on each part, and finish by laying away and tapering the ends as in a tack-knot.

Shunt. When an electrical current passes by more than one path, that specially intended for its passage is termed the main circuit, while the rest are termed derived circuits.

The effect of introducing derived circuits is to diminish the strength of the current flowing in the main circuit, and when a single derived circuit is applied for this purpose, it receives the technical name of a "shunt."

The law of shunts is as follows: —

The strength of current in any branch of a system of derived circuits, or "multiple arc," as it is termed, varies inversely as the resistance of that branch. Hence by varying the resistance of the shunt we vary the strength of current flowing through the main circuit.

The resistance of the shunt bears a mathematical relation to the current passing in the main circuit, and that by knowing the one the other can be calculated. Thus, in the case of a galvanometer with a variable shunt interposed between its terminals, by observing the deflection of the needle when the shunt is in circuit, we can determine what the deflection would have been without the shunt, by multiplying the reading by a variable factor termed the "multiplying power" of the shunt.

Another fact worthy of notice in connection with this portion of the subject is that by means of a variable shunt the same deflection of the needle of a galvanometer may be reproduced by currents widely differing in strength, and hence all errors due to inequalities in the value of an uncalibrated scale are entirely avoided.

When an electro-magnet situated on a line of telegraph is shunted by a rheostat or "simple shunt," that rheostat tends to become the path by which the extra currents are discharged, and so prolonged is the magnetization, that if the circuit be closed and opened with any degree of rapidity, the armature sticks or remains permanently attracted — a principle which has been employed in double current translation. This retardation is at its maximum when the resistance of the shunt equals that of the electro-magnet. But should the shunt be a second electro-magnet, or, in other words an "electro-magnetic shunt," then the extra current formed in it opposes that formed in the electro-magnet, and both send a current back into the line. The current from the shunt, however, may be so exalted as to neutralize and even overcome that formed in the electro-magnet itself. So that by a properly arranged electro-magnetic shunt, the magnetic retardation in the electro magnet itself may be reduced to a minimum, while a current is sent back into the line immediately after each signal, thus tending to increase the speed at which the line can be worked.

Shunt Box. (*Electricity.*) An English term equivalent to a switch box or board.

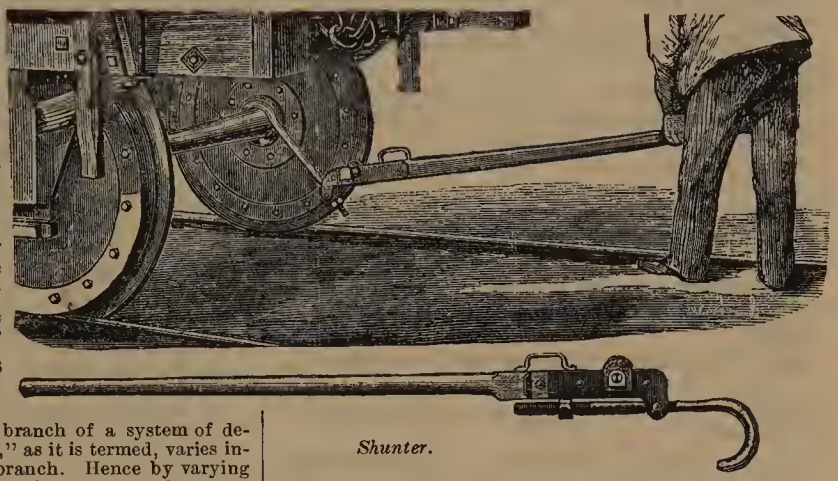
Rymer-Jones . . . * "*Telegraphic Journal*," vii. 128.

Shunt'er. A hand propeller for cars. See Pinch Bar, etc., Fig. 3725, p. 1706, "*Mech. Dict.*"

The illustration, Fig. 2254, will give a general idea of the "Shunter," which is a wooden lever, 6′ long, with a pair of side-plates fixed to it at one end, to which is attached a swivel, through which passes an iron rod, having a hook at one end which hooks over the axle. The other end has a screw with a loose nut, to shorten or lengthen the rod according to the size of wheel; from a saddle which crosses the lever and binds the side plates to the wood, project two lugs, shaped to fit the flange of the wheel. When the shunter is in position with the hook over the axle, the lug comes in contact with the flange of the wheel. Upon raising the lever the lug is pressed against the flange in proportion to the force applied, and becomes fixed; upon continuing to raise the lever, the wheel is caused to revolve in the same direction, and the carriage is propelled forward; upon lowering the lever, it immediately becomes loose, falls again, and the action being continued — every upward movement propels the carriage forward from 9″ to 15″.

To adjust the shunter for working, drop the hook over the axle, and hold out the wooden lever horizontally, then regulate the length of the hook by running the nut forward or back as may be required, so as to bring the projecting lug on

Fig. 2254.



Shunter.

the side of saddle about 1″ distant from the edge of the wheel; the length of rod being once adjusted will suit all wheels that do not vary more than 1″ in diameter.

Shunt'ing En'gine. A British term for a yard or switching engine. See one type of such from "*Engineering*," reproduced in "*Scientific American Sup.*," * 4071.

See Switching Engine.

Shunting engine.

London & N. W. Ry., Br. . * "*Engineering*," xxx. 184.

Shut'ter Dam. A dam or gate operated by the water.

Some recent improvements in France of shutter dams, worked by hydraulic pressure, have attracted much attention among engineers, the system comprising — first, a series of great wooden water-gates, movable around a horizontal axis working in a cast-iron shoe secured to the floor of the dam; second, hydraulic presses applied on the down-river side of the floor, solidly anchored in the masonry and designed to work the gates — the piston of each press bearing a cast-iron cross-head working in slides, to which cross-head three rods are attached, for communicating the pressure to a cross-bar fastened in the center of the movable gate; third, a series of copper tubes which puts each press in communication with the generator or reservoir of power destined to transmit water under the pressure of the hydraulic presses; and fourth, hydraulic works built on the abutment of the dam — these comprising a turbine with a vertical axis, a double force pump which receives motion from the turbine, and a reservoir of force. The pumps and the reservoir communicate with each other, and with the presses, by means of three-way cocks, which let the water either into the reservoir or into the presses, or empty it into a discharging tube. The maneuvering of the gates is effected by simply moving these cocks. By putting in communication each press either with the pumps or with the reservoir of power under a sufficient pressure, an ascending motion of the piston is effected, and in consequence the gate rises. By opening the cock into the waste pipe, the water escapes under pressure of the gate, the "*corps de presse*" is emptied, and the gate sinks.

The reservoir force is a regulator of the play of the pumps and also permits the dam to be raised sufficiently, in case of need, to put the turbine in motion.

Shut'ter Eye. An eye for hanging a shutter to, having a projecting flange or support, which is built into the wall.

Shut'tle. A section of a movable dam in the

modern system of movable dams. See Watson's Report, Vienna Exposition, vol. iii., "*Civil Engineering.*"

In M. Boule's design the shuttles are placed in tiers, between slight wrought-iron upright supports, 3½′ apart, carrying the foot-path, so that the shuttles can be readily removed and replaced. In America shuttles hinged at the bottom, maintained in their places by props, and falling down flat on the apron of the weir when the props are removed, have been introduced.

See BARRAGE DAM.

Shut'tle Race. The inclosure in which the sewing-machine or loom shuttle travels.

Si-cil'i-enne. (*Fabric.*) A silk and wool French goods.

Sick'le Grind'er. A clamp and rest hold the sickle on the grindstone in such a position that all the teeth receive the same bevel.

See Fig. 3248, p. 1493, "*Mech. Dict.*"; Fig. 4205, p. 1898, *Ibid.*

Side Ac'tion. (*Fire-arm.*) One in which the locking fast of the barrel when closed is by a side lever.

Side Bar. A form of spring to give a buggy a sidewise, rolling motion instead of the forward pitching.

Side Bear'ing. Supports which are placed on each side of the center-pins of a car, and intended to prevent too much rolling or rocking motion of the car-body.

Usually there is a plate of iron or steel attached to the body-bolster on each side of the center-pin which is called a *body side-bearing*, and a corresponding plate, block, or roller on the truck-bolster which is called the *truck side-bearing*.

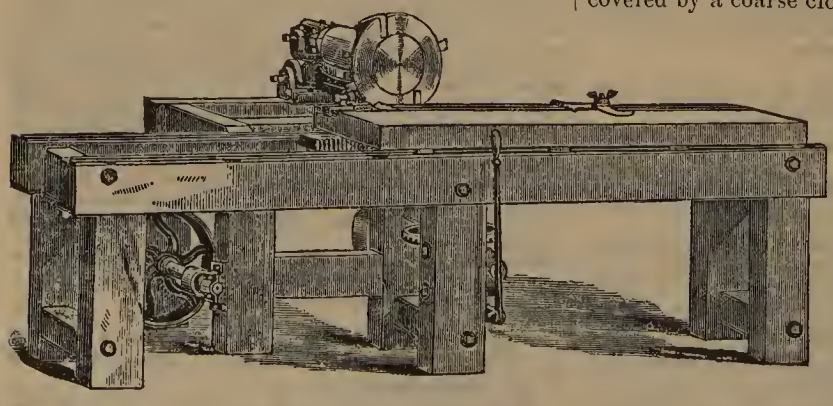
Side Con-dens'ing Lens. A condensing lens, for the illumination of opaque objects, fitting into any of the holes on the stage of a microscope. A pair of stage forceps also fits into the holes to hold small insects.

Side File. For trimming up the outside edges of the cutting points of saws after setting, to prevent setting.

Side-pla'ning Ma-chine'. Designed for planing or jointing the edges of short boards where an accurate glue joint is required, such as cabinet and piano-forte work, and for trying out pieces for small frames, etc. It consists of a long, narrow frame with a self-feeding carriage on which the stuff is fastened by adjustable dogs, and a wing to hold a cutter head.

These machines are usually made to work stuff 5′ long, but can be made to work longer when ordered, at an extra cost. The cutter head is adjustable in all directions, has cast steel arbor, and patent self-oiling boxes.

Fig. 2255.



Side-planing Machine.

Si-der-aph'thite. The name of a new iron amalgam which is composed of 63 parts of iron, 23 nickel, 4 tungsten, 5 aluminum, 5 copper. It resists sulphureted hydrogen, is not attacked by vegetable acids, and only slightly by mineral acids. It is really more useful than standard silver, while it can be produced at a cost not exceeding that of German silver. For alloys which have to be silver-plated to prevent oxidation, the inoxidizable iron, as the above is called, is stated to be a perfectly successful substitute.

Fig. 2256.

Side Reflector.

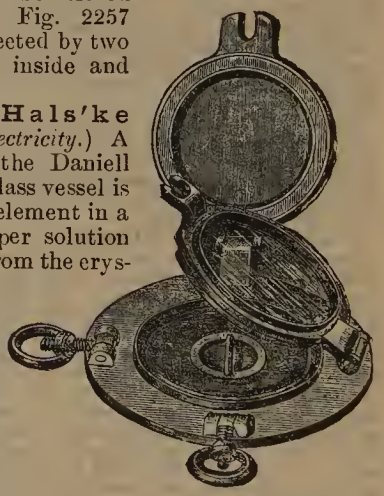
Side Re-flect'or. A means of reflecting parallel rays, mounted so as to bring them to a focus on an opaque object under the microscope.

Si'der-o-stat. An astronomical instrument designed to keep a star within the same portion of the field of a telescope for observation.

An admirable example may be found in Léon Foucault's siderostat in "*L'Astronome Pratique et les Observatoires, en Europe et en Amerique*," by *André & Rayet*. Paris, 1874.

Side Scut'tle. An opening in the side of a ship, to admit light and air, but which can be closed water-tight. In Fig. 2257 the glass is protected by two dead doors, one inside and one outside.

Fig. 2257.



Side Scuttle.

Sie'mens-Hals'ke Bat'te-ry. (*Electricity.*) A modification of the Daniell battery. In a glass vessel is a spiral copper element in a sulphate of copper solution kept saturated from the crystals contained in a tube through which passes the positive pole. Upon the copper rests a pasteboard disk supporting the diaphragm composed of acidulated paper pulp covered by a coarse cloth. Upon this is placed the zinc element from which the negative pole rises. The vessel is charged by being filled with water.

Prescott's "Electricity" . . * 52.
Sabine's "Electric Teleg." . * 226.
Niaudet, American transl. * 160.

Sie'mens-Mar'tin Steel. (*Metallurgy.*) Steel made by the Martin process; melting cast iron in a Siemens' reverberating furnace, and adding wrought iron until the required attenuation of the carbon is attained. Oxides and free oxygen are removed by fer-

ro-manganese and the metal run into molds. See p. 2365, "*Mech. Dict.*"

"While the Bessemer process has been making rapid strides, a rival process has gradually grown up by its side, which I cannot pass over without remark. I allude to the open-hearth steel process, with which my name and the joint names of Siemens and Martin are associated. The conception of this process is really as old as that of cast steel itself. The ancient Indian steel, the Wootz, was the result of a fusion of a mixture of malleable and cast iron. Reaumur, as already stated, proposed to melt wrought iron and pig metal together, for the production of steel, as early as 1722; and G. B. Heath — to whom we owe the important discovery that by the addition of manganese to cast steel its malleability is greatly increased — endeavored to realize the conception of producing steel in large masses upon the open hearth of the furnace in the year 1839, and he again has been followed in these endeavors by Gentle Brown, Richards, and others in the same direction.

"When, in 1856, I first seriously gave my attention, in conjunction with my brother, Frederick Siemens, to the construction of a regenerative gas furnace, I perceived that this furnace would be admirably adapted to the production of steel upon the open hearth, and proposed it for such a purpose to Mr. Abraham Darby, of Ebbw Vale, in 1861. Ever since that time I have been engaged in the realization of this idea, which has been retarded, however, by those untoward circumstances which ever intervene between a mere conception and its practical realization. Although two of my earlier licensees, Mr. Charles Attwood, of Tow Law, and the Fourchambault Company, in France, with whom was my late esteemed friend, Mons. Lechatelier, Inspecteur-General des Mines, succeeded, in 1865 and 1866, in producing steel upon the open hearth, they did not persevere sufficiently to attain commercial results; but it was not until after I had established experimental steel works at Birmingham that I was enabled to combat in detail the various difficulties, which at one time looked well-nigh insuperable. While thus engaged, Messrs. Pierre and Emile Martin, of Cereuil, — who had obtained licenses for furnaces to melt steel both in pots and on the open hearth, — succeeded, after a short period of experimenting, in introducing into the market open hearth steel of excellent quality.

"While Messrs. Martin thus gave their attention to the production of steel by the dissolution of wrought iron and steel scrap in a bath of pig metal, my own efforts were more especially directed to the production of steel by the use of pig metal and iron ores, either in the raw state or in a more or less reduced condition, which latter process is the one mostly employed in this country." — *C. W. Siemens.*

Sift'er. An apparatus to dust dry poison upon plants to destroy insects. For instance: —

Young's sifter to destroy cotton worms. See "*Comstock's Report on Cotton Insects*," 1879, * p. 246.
Willis's sifter, *Ibid.*, * p. 248.
Davis's sifter, *Ibid.*, * p. 249.
Levy's sifter, *Ibid.*, * p. 250.
Eldridge's sifter, *Ibid.*, * p. 251.
Sifting reel for guupowder, Br., * "*Engineering*," xxv. 37.

Sight. "*Ordnance Report*," 1877, Appendix L, Fig. 110, and p. 582, shows and describes the following: —

Werder (Bavarian).	*Vetterlin* (Swiss).
Comblain (Belgian).	*Chassepot* (French).
Mauser (Prussian).	*Werndl* (Austrian).
Berdan (Russian).	*Martini-Henry* (British).

Mauser rifle (Prussian) sight, Figs. 4, 5, 6, article "*Armes à feu*," vol. iv., *Laboulaye's* "*Dictionnaire des Arts et Manufactures*," ed. 1877.

There are various names of sights among which are the following; some of them are synonyms, and some merely refer to position, actual or relative.

Aperture sight.	Leaf sight.
Bar and Bead sight.	Muzzle sight.
Bar and slit sight.	Open bead sight.
Beach combination sight.	Open sight.
Bead sight.	Peep sight.
Buck-horn sight.	Pin-ball sight.
California sight.	Plain sight.
Clover-leaf sight.	Rear sight.
Covered sight.	Reflecting sight.
Front sight	Slit bar sight.
Globe sight.	Sporting sight.
Graduating sight.	Telescopic sight.
Hausse.	Vernier-scale sight.
Hind sight.	Wind gage sight.

Fire-arm, *Warfield* . * "*Scientific American*," xlii. 245.

Sig'moid Cath'e-ter. (*Surgical.*) A catheter named from its resemblance to sigma (*s*). Fig. 1190 *d*, p. 204, "*Mech. Dict.*"

Sig'nal. A means of communicating between distant points by signs having a known meaning.

Captain Maryatt's code was used in England till 1857, when the English board of trade issued "The Commercial Code of Signals for all Nations," which is now in general use for marine signals. It requires 18 flags, 4 flags only to be used at a time, giving 20,000 messages.

The "Telegraphic Dictionary" and "Signal Box," United States code of 1857, had two books of signals, a distinguishing flag being used when the "Telegraphic Dictionary" was used.

In 1859 Costin's plan was adopted. See *Myer's* "*Manual of Signals*," New York, 1866, for field work. varied information; or methods and codes by color flags, motion of flags, torches, or of lanterns, flashes, oscultatious. or puffs; semaphonics, rockets, colored lights, and by sound.

Ward's "*Semaphonic Color Signal*," Philadelphia, 1866. Radical color patches in green, white, and red; read from the center outward across the concentric circles, which inclose numerals and letters.

Ward's "*International Code*," Auburn, N. Y., 1867. Message indicated by dips of the flag, so many dips representing a given letter, and a code of abbreviations for possible messages.

Ward's "*Code*," Auburn, N. Y., 1858. System of 10 flags and 3 repeaters, and a code of 11,000 possible messages.

Roger's "*American Code.*" New York, 1854. Ten breeze and calm flags with a dictionary of 60,000 possible messages represented by the number flags.

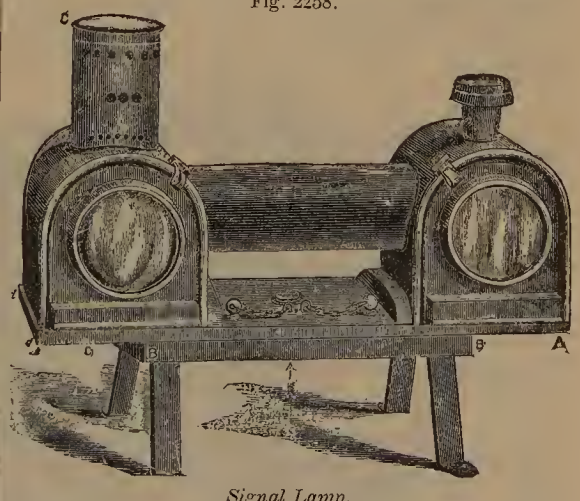
Jink's "*Brachial Telegraph.*" New York, 1852. By arm motions.

Block system, *Whyte* . . "*Van Nostrand's Mag.*," xv. 89.
Box, district teleg., *Field* * "*Mining and Scientific Press*," xxxiv. 281.
Buoy, *Courtenay* . . . * "*Scientific American*," xxxv. 19.
Control appa., railway.
Thompson, Br. . . . * "*Engineering*," xxx. 171.
Compass, fog, *Hughes* . * "*Mining and Scientific Press*," xxxviii. 129.
Equipment, Penn. Ry. . * "*Railroad Gazette*," xxi. 251.
Signaling instrumeut,
electric, *Hadden* . . * "*Scientific American*," xli. 395.

Sig'nal Lamp. An automatic distance indicating signal lamp, the purpose of which is to indicate to engineers the distance that their engine may be from the rear of a preceding train, thereby preventing tail collisions.

In the form shown there is but one lamp, the light of which is thrown to the right, through the cylinder, striking a mirror (in the right-hand elevation), so adjusted as to

Fig. 2258.



Signal Lamp.

reflect a strong white light, which at a distance of one mile and upward, is absorbed by the red light at the left, but inside of a mile, as the train approaches, the two lights separate, thus at $\frac{7}{8}$ of a mile blending together, $\frac{3}{4}$ of a mile, 3″ apart; $\frac{1}{2}$ mile, 12″ apart, $\frac{1}{4}$ mile, 20″ apart; and $\frac{1}{8}$ mile, 28″ apart; thus enabling the engineer to tell when he is running faster than the preceding train, when he is running slower, when the train stops, or when it commences backing. The different conditions of the atmosphere do not interfere with the relative spaces between the two lights.

Lamp, Penn. Railway . * "*Engineering*," xxiii. 146.
Lantern, marine.
Wymer, Br. . . . . * "*Engineering*," xxi. 89.
Posts, standard . . . * "*Railroad Gazette*," xxiii. 631.
Tower, Penn. Railway . * "*Engineering*," xxiii. 143.
Wire compensator, Br. . * "*Engineer*," l. 32.
Great E. Railway, Br. * "*Engineer*," xlvi. 414.

Sig'nal Lan'tern. For signaling by flashes of light.

Otter's signal lantern with registering apparatus is intended for transmitting signals at night, both at sea and on land, and at distances not exceeding eight to ten miles; the controller is for registering given or received signals, its aim being principally to prevent errors. The system used in telegraphing is the same which has lately been tried and partly adopted in several countries; but the means are different.

Morse's telegraphic lines and dots are represented by long and short flashes; letters and figures, by various groups of flashes. Flashes belonging to the same group are separated by dark intervals of short duration, groups and sentences by dark intervals of longer duration (pauses), the extent of the latter being limited by the skill of the operators.

Two strings are suspended from the lantern and passed through the controller. By pulling the one of these strings long flashes (lines) are produced, and by pulling the other, short flashes (dots).

By pulling a third string, hanging down from the controller, between the two strings from the lantern, a pause will be produced, and the signalized letters or figures are impressed on a self-acting strip of paper

The strings should be pulled with even force and to their full extent, but without jerking.

Signaling between two or more places is effected in the most convenient and sure manner, by each receiver of a signal repeating on his lantern and controller the signs conveyed. The communication is thereby printed on the above mentioned strip of paper, without it being necessary for the receiver to understand the telegraphic characters.

The lantern may also be employed independently of the controller in transmitting signals and vice versa, the controller used independently of the lantern in receiving signals. In the latter case, three keys, attached to the upper part of the controller should be used instead of the corresponding strings.

A suitable weight attached to the block under the lantern brings into action a proposed new method of distinguishing lights from each other, rendered necessary by their increasing number. It is proposed that each light, on the principle of the above signals, shall describe its name every alternate or every third minute, by combinations of long and short flashes; for the exact reading of which a simple and easily worked apparatus is annexed.

These lights may be either revolving or fixed. In the former case the flashes will be produced by lenses, in the latter by Venetian blinds.

Sig'nal-ing Tar'get. A form used at railroad crossings and switches to indicate to the engineer which train has the right of way, or whether the main track or switch is open.

Two targets, generally a round and an oblong one, and generally painted red and white respectively, are set at right angles to each other on a revolving shaft. These are turned by the target-man by means of a hand-lever, so as to bring either one in a line across the road, in view of the engineer, and indicate to him whether the main track or a switch is open. At night a red or white light on the shaft gives the same information.

A common format ordinary switches is an upright pivoted lever with target on top. The movement to the right or left indicates the position of the switches.

Sil'i-cate Board. An incombustible board for roofing. Saturate alternate layers of pasteboard with silicate of soda, and with a solution of chloride of barium or other salts, which produce insoluble silicates, such as salts of zinc, calcium, magnesium, and aluminium. The mass of the board becomes saturated with insoluble silicate of barium and silicic acid, which renders it fire and weather proof.

Sil'i-cate Cot'ton. A name for *slag wool*. See SLAG WOOL, "*Mech. Dict.*," p. 2198, and MINERAL COTTON, p. 1446.

Krupp, Essen . . . . . "*Engineering*," xxi. 19.

Sil'i-con Steel. A steel in which silicon replaces a part of the usual carbon. For instance: —

Nes Patent, 102,068, Feb. 1871.

Carbon	0.600
Silicon	0.552
Iron	98.848

He claims a steel in which the proportion of silicon to carbon is not less than 1 to 2.

See also his patents: —

104,873,	108,287,	109,752,
123,191,	125,212,	145,005.

His silicon is a mica-schist magnetite containing from 30 to 40 per cent. of magnetic oxide of iron. The process of manufacture of steel consists simply in mingling the pulverized ore with molten cast or pig iron, and by oxidation reducing the percentage of carbon until it reaches the standard of low steel. The ore used is from York county, Pa. Views as to the value of this process differ widely, though it seems undeniable that rails made by it last longer than iron, and can be rerolled.

"*Iron Age*" . . . . . xxiv., Dec. 25, p. 3.
"*Van Nostrand's Eng. Mag.*" xvii. 282.
"*Eng. and Min. Journ.*" . . . xxvi. 416; xxx. 251, 265.
"*Am. Manuf. and Iron World*" xxiv., Feb. 28, p. 8; xxvi., Jan. 30, p. 8.

On, *Pourcel*, Fr. . . "*Van Nostrand's Mag.*," xix. 550.

Silk. A fiber, the product of the silk worm.

The silk industry of America is growing to very satisfactory proportions, over 40 per cent. of the silk goods used in the country in 1882 being home made. There were some $40,000,000 worth manufactured, as follows: machine twist, $7,000,000; dress goods. $5,000,000: satins, $1,500,000; ribbons, $7,000,000; handkerchiefs, $5,000,000; fringes and dress trimmings, $6,000,000; sewing silk, $1,500,000; ties and scarfs, $1,000,000; tassels and milliuery silks, $2,000,000; balance in upholstery and other trimmings. Of this amount nearly one half was manufactured in New Jersey, while Connecticut, Massachusetts, New York, and Pennsylvania produced three fourths of the remainder. The number of establishments manufacturing was about 400, employing nearly 9,000 looms, 6,000 spindles, and paying in wages, $10,000,000. Our manufactories import $10,000,000 to $13,000,000 worth of raw silk annually, and the duty on silk goods amounted in 1880 to $32,000,000. against $45,000,000 for woolen goods, and $51,000,000 for iron and steel. The production of the raw silk at home is increasing very rapidly, however, and we hope to see sufficient raised in the United States in a few years to supply the home demand. The southern States and many northern States are well adapted to the rearing of the silk worm and its food, the white mulberry tree: while a number of parties like Virion Des Lauriers, of New York, and the Women's Silk Association, of Philadelphia, are sending silk worm eggs and mulberry trees to all parts of the country, and buying the cocoons produced. The care of a few silk worms for a month in the spring is both interesting and profitable work, and can be managed exclusively by women and children.

Silk and silk culture in the United States, see *Hayes'* "*Centennial Report*," v. 92-111.

Silk culture, book on. Virion des Lauriers, 201 East 63d street, New York.

See "*Mech. Dict.*," pp. 2179-2182.

A long account of production and manufacture in *Laboulaye's* "*Dict. des Arts et Manufact.*," tome iii., article "*Soie.*"

Culture in Alabama . . "*Scientific Amer.*," xxxviii. 391.
Finishing machines.
Buffand, Lyons . . * "*Engineering*," xxvi. 196.
Buffand, Fr. . . . * "*Scientific American Sup.*," 2369.
Industry of N. Italy . "*Scientific American Sup.*," 2662.
Europe . . . . . * "*Scientific American Sup.*," 1671.
Man. in United States . *Wycoff*, 10th "*U. S. Census.*"
Manufacture of sewing. "*Scientific American*," xl. 100.
Manufacture, American "*Scientific American Sup.*," 3854.
Production . . . . . * "*Scientific American Sup.*," 1480.
Reeling, etc . . . . * "*Scientific American Sup.*," 4779.
Silkworm eggs, electricity in hatching . . . * "*Scientific American*," xxxiv. 271.
Silk worm, treatment of * "*Sc. American Sup.*," 2773, 2779.

Silk De-gum'ming Ma-chine'. A machine for treating the cocoons to deprive the filaments of their glutinous qualities, which, as first spun by the worms, cause the thread to adhere too closely.

The thread of silk as it unwinds from the cocoon is valueless for manufacturing purposes, several of them combined going to make the staple of commerce. The degumming in the silk districts is accomplished as follows: The cocoons are plunged into water near the boiling point, and moved about so that the gum which fastens the threads becomes uniformly and thoroughly softened. They are then beaten with a small birchen broom, having the tips split, so that the loose threads

readily fasten to them. After beating a short time, the operator gets all the cocoons fastened, and taking the bundle of threads, shakes the cocoons till each hangs but by a single one. She now takes up five or more threads (*brins*) according to the quality of silk wanted, unites them, and introduces the combined staple or strand (*fil*) into a little glass eye on one side of the basin. She then forms a second similar strand and introduces it into a second eye on the other side. The strands are then brought together, twisted several times, separated above the twist, and introduced into two other glass eyes or ringlets, through which they are led, one to each end of the reel or *tambour* which is kept revolving in a steady, rapid manner, and to which is also given a certain back and forth side motion. The great object in reeling is to get the threads uniform, rounded, well joined, properly freed from moisture, and so crossed on the reel that they will not stick or glaze, as it is termed. These objects are attained by the twisting and the to and fro lateral movement of the reel, as also by properly regulating the distance between reel and basin.

The uniformity of the thread depends on the skill of the operator, who must supply a new thread as soon as one begins to give out. This is called nourishing the silk, and is done by dexterously casting, with the thumb, the new thread upon the combined strand, to which it immediately adheres. In this she must use much judgment, for the silk of a cocoon gradually gets lighter and finer as it approaches the end, and the uniformity of strand does not entirely depend on the uniformity in number of the individual threads forming it. Whenever the silk rises in locks the temperature of the water is known to be too hot, and when it unwinds with difficulty the temperature is, on the contrary, too low. The operator is supplied with a skimmer with which to remove all chrysalides and refuse silk; also, with a basin of cold water in which to cool her fingers, which are being constantly dipped in the hot basin. This constitutes the whole operation of unwinding; but before the skeins, as they come from the reel, are ready for the manufacturer they must undergo still farther manipulation. The staple is first passed through a cleanser, consisting of a clasp lined with cloth, which catches any loose silk or other matter that may be adhering to it. It is then further cleansed and purged by being passed through four similar cleansers (*purgeurs*), then twisted about 500 times to the yard, then doubled and twisted about 400 times to the yard. It is finally run on reels about 1½′ in diameter, and taken off and twisted in a peculiar knot or hank. Through all these operations the oscillating to and fro lateral motion is kept up, so as to produce the diagonal crossing of the strands, and it will be readily understood that each staple is, in the end, composed of 10 or more of the simple threads first spun by the worm.

Silk Ma-chin′er-y. Danforth Locomotive and Manufacturing Co. (Paterson, N. J.) use —

1. Winding frame for singles.
2. Silk spinning frame for singles; the spindles making 8,000 revolutions per minute.
3. Doubling frame in which the twisted singles are laid together on spools.
4. Reeling mill for spinning doubles; the spindles making 4,500 revolutions.

The size of the thread is according to the number doubled together, for the term is used whether 3 or 20 may be so laid up. Organzine may be two-thread doubles; tram may be 3 to 6 thread, or more. Spindle stop patent, March 24, 1876.

Nonotuck Silk Co.'s (Florence, Mass.) machinery for throwing and finishing spool silk consists of

1. Frame for winding on to spools from the imported skeins of raw silk. Machine has a glass eye for the singles to pass through. Hill's patent.
2. For doubling several threads (from 3 to 20) together as required to obtain the required thickness. This machine has Dimock's patent detachable drop-wire to stop the winding on that particular spool if either of the individual strands should break.
3. For spinning, or twisting the threads together; the machine having a self-oiling spindle.
4. A machine for doubling several of these spun strands together.
5. For spinning these doubled threads, forming a finished cord.
6. For reeling into hanks.
7. Dyeing follows.
8. A soft silk winding frame with Brown's patent rocking or oscillating motion to the top skein carrier to facilitate the work.

A Spool Printer and Spooling Machine, which see.

Silk Man′u-fac′ture. See manufacture of spun silk by Cheney Bros, South Manchester. *Hayes' "Centennial Reports,"* v. 100–102.

Of Paterson, N. J., *Ibid.*, 102-106.
Of Horstman, Phila., *Ibid.*, 107
In U. S., Wycoff, 10th Census Report.

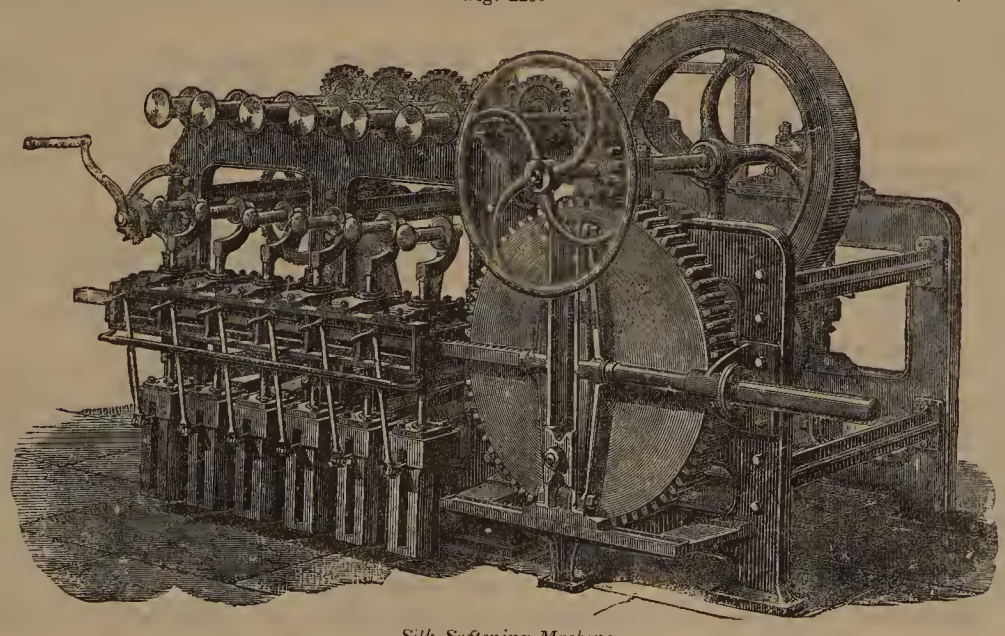
Silk Reel. A reel for winding the silk as it comes from the cocoons in the degumming process. The silk is passed through glass eyes, and through a guide having a transverse back-and-forth motion.

Silk, Sew′ing. See manufacture of sewing silks and machine twist, Nonotuck Co., Florence, Mass., and Danforth Manufacturing Co., Paterson, N. J., *Hayes "Centennial Reports,"* v., 98–100.

Silk Soft′en-ing Ma-chine′. A machine for softening and polishing silk after dyeing.

The skeins of silk are hung over two tiers of bobbins, the lower set free to move up and down, and are stretched by weights hung from the lower bobbins. This tier also moves faster than the upper ones, and has a reciprocating motion, horizontally, to twist and untwist the silk while revolving. See Fig. 2259.

Fig. 2259.



Silk Softening Machine.

Silk Sol'vent. For dissolving silk fiber to be mixed with wool, cotton, or linen fiber for imitation silk goods.

Schlossberger first suggested the use of an ammoniacal solution of protoxide of nickel for dissolving silk. Persoz proposed to use chloride of zinc, and Spiller used concentrated hydrochloric acid. J. Loewe recently described a new solvent, the cold alkaline solution of copper with glycerine, which is not inferior to the above, and with great dilution surpasses them. In very weak solutions, the silk is acted upon slowly; if moderately concentrated, the silk swells up on moistening it a short time; and with a larger quantity it soon dissolves to a thick liquid, which can be filtered, although it filters slowly. By adding hydrochloric acid to the filtrate, the dissolved silk separates in the form of a white jelly; frequently this separation is very slow, and the filtrate appears like a cold solution of gelatine. Wool, cotton, and linen, after being in contact with this solution for hours, is neither attacked by it nor taken up by it. It appears as if the solvent power of the alkaline glycerine and copper solution only extends to the silk. In mixed fabrics, the silk may be readily detected, and even quantitatively determined.

Silk Spin'ner. A machine for spinning and twisting singles for organzine. It has self-oiling spindles and steps. The latter are winged pieces which rest in cups, the wings preventing the vertical motion of the oil which might cause it to flow over the edge of the cup. A cover closes in the oil chamber and excludes dust. The spindles revolve 7,200 times per minute.

Silk Spool'ing Ma-chine'. A machine for winding silk on to merchant spools. See SPOOLING MACHINE; SILK SPOOLING AND MEASURING MACHINE.

Silk Spool'ing and Meas'ur-ing Ma-chine'. A machine for measuring on to bobbins the exact quantity of sewing or machine silk thread; say 100 or 200 yards, or other prescribed quantity.

The one used by Holland Manufacturing Company of Willimantic, Connecticut, has a finger which rotates on a dial-plate, moved by contact of an impelling roller which rotates in contact with the spool.

John D. Cutler & Co.'s (Paterson, N. J.) machine for spooling and measuring silk thread (Patent, March 3, 1874) has a friction wheel of determinate diameter resting against the thread, and communicates motion by worm-wheel to a train which actuates a printer on a graduated dial-plate.

Silk Stretch'ing. A machine for stretching and polishing after dyeing. See SILK SOFTENING MACHINE and Fig. 2259.

Silk Test'ing Ma-chine'. A spring balance has a bar graduated to a scale of weights for the purpose of testing the strength of the thread or filament. The thread is looped over the hook on the end of the spring-bar, and the ends being twisted around the finger, the thread is broken, a spring-catch detaining the bar so that the point at which it broke may be observed at leisure.

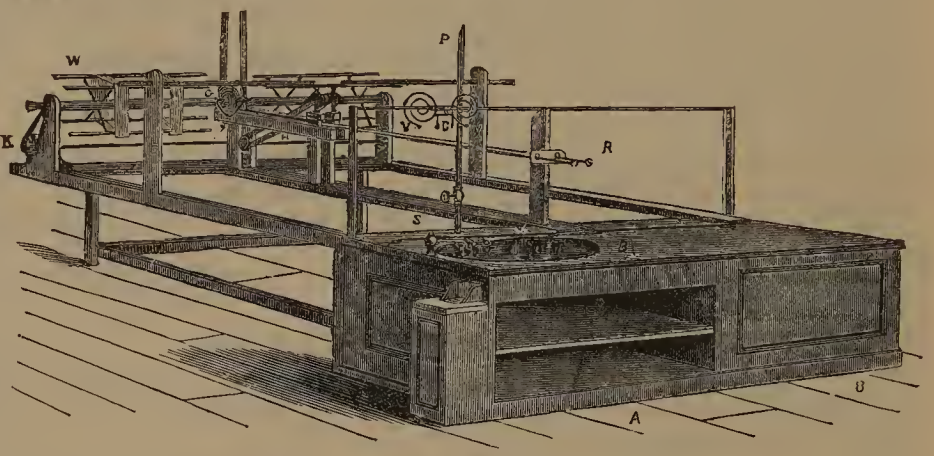
Silk Thread. Sewing-silk is two-cord and twisted from left to right, and machine-twist is three-cord and twisted from right to left.

Silk Wash'ing Ma-chine'. One in which the cocoons are passed to rid them of dirt, worms, glutinous and other refuse matter. See DEGLUTINIZING MACHINE above.

Silk Wind'er. For reeling the silk from the cocoons.

This apparatus, shown in perspective in the accompanying illustration, is double. Each half consists simply of a metal lined basin, *B*, supplied by a faucet, *S*, with cold water, heated to such temperature as may be desired, by steam from the pipe *P*. Immediately above and back of the basin is a transverse bar, *H*, which bears projecting horizontally from it, two stems carrying the *filières F*, which are porcelain disks half an inch in diameter, and each pierced in its center with a small vertical hole. The horizontal bar has a slight traversing motion. Above and across the machine is a transverse bar carrying the *croiseur* or *twister C*, which is a tiny reel with a vertical axis, and set in motion at will, by a train of clock-work. At each side of the *croiseur* is a *tremble*ur or vibrator, *V*, which is a spiral spring bearing at its free end a loop fitted with a heart-shaped glass plate. Midway of the machine rise standards which bear a reciprocating cross-bar, fitted with a triangle of wire, apex downward. At the back of the machine are standards bearing a reel operated by a crank or by power, the belt being thrown into

Fig. 2260.



Silk Winder.

operation by a clutch actuated by the rod *R*. The cocoons (containing the dead chrysalides) being placed in a basin of hot water, are softened and rendered more easy to unravel. The free or outer ends of the cocoons are gathered by beating the floating mass gently with a stiff brush of twigs. Two sets of six each of these being selected, are passed upwards through the holes in the porcelain *filières F*, are crossed, passed through the loops on the *croiseur*, through the niche in the glass bushing in the vibrators, then through loops in the triangle, and then to the reel. The machine being then set in operation by the hand crank or by the belts, the delicate threads are unwound from the bobbing cocoons, brought together, intimately twisted, and wound on the reel, which is seen to contain two hanks of the twisted thread.

Silk'worm Nur'se-ry. A frame is made with light square vertical posts connected by horizontal parallel bamboo rods. The rods are placed at suitable distances to support a series of flat trays made of rice straw, in which the silkworms are reared.

Sil'ver. Equivalent 108, symbol Ag. (argentum), specific gravity 10.5, point of fusion, 1873° Fab. Generally occurs as a sulphide, and is often associated with other metals. The ore is ground and the silver separated by amalgamation. "*Mech. Dict.*"

Alloy	"*Scientific American*," xli. 103.
Silvering glass, *Draper* .	"*Scientific American Sup.*," 1670.
Siemens	"*Scientific American Sup.*," 1670.
Petitjean	"*Scientific American Sup.*," 1670.
Laval	"*Scientific American Sup.*," 1670.
Silvering iron	"*Scientific American*," xxxiv. 276.
Ware	"*Sc. Amer.*," xxxvi. 287, 291, 292.

See "*Mech. Dict.*," 982, 983, 2182–2185, and 405 *supra*.

Silver mill, *Boss* . . .	* "*Scientific American Sup.*," 2464.
Cerro de Pasco . . .	* "*Eng. & Min. Jour.*," xxvi. 436.
Silver plate works.	
Reed & Barton . . .	* "*Scientific American*," xli. 287.
Silver smelting processes.	*Painter's* "*Report Vienna Exp.*,"
Andreasberg . . .	iv. 115.

Pilram, 163, *Augustin* . *Painter's* "*Report Vienna Exp.*," iv. 134.
Schemnitz, 179, Silesian *Painter's* "*Report Vienna Exp.*," iv. 136.
Soldering . . . . . "*Scientific American Sup.*," 1302.
Imitation . . . . * "*Scientific American*," xxxiv. 368.

Sil'ver Al-loy'. 65 parts of iron and 4 parts of tungsten are melted together and granulated; also 23 parts of nickel, 5 of aluminum, and 5 of copper, in a separate crucible, to which is added a piece of sodium in order to prevent oxidation. The two granulated alloys are then melted together. Both alloys resist the action of sulphuretted hydrogen.

See also "*Scientific American*," xli. 103.

Sil'ver Glass. An ornamental ground and cut glass. This glass can be used in the place of plaster, marble floors, or wood inlaid work.

Patented February 2, 1875, *Jones*.

Sil'ver-ing. The formula for *silvering by dipping* is as follows: —

Dissolve 20 grams of silver in 60 grams of nitric acid, and precipitate with a solution of 20 grams of caustic potash in water upon a filter, and wash with water; then redissolve upon the filter with a solution of 100 grams of cyanide of potassium in water; then dilute the whole to 2 liters with distilled water, and use like the gilding solution described in Gilding by Dipping, under GILDING, p. 398, *supra*.

Silvering by Cold Rubbing. — Make paste by thoroughly grinding in a porcelain mortar, out of the light —

Water	3 to 5 oz.
Chloride of silver	7 oz.
Potassium oxalate	10½ oz.
Salt (common table)	15 oz.
Sal ammoniac	3¾ oz.
Or, Chloride of silver	3½ oz.
Cream of tartar	7 oz.
Salt (common)	10½ oz.
Water, to form a paste.	

Keep in a covered vessel away from the light. Apply with a cork or brush to the clean metallic (copper) surface, and allow the paste to dry. When rinsed in cold water the silver presents a fine frosted appearance, the brightness of which may be increased by a few seconds' immersion in dilute sulphuric acid or solution of potassium cyanide. The silvering bears the action of the wire brush and of the burnishing tool very well, and may also be "oxidized." Should a first silvering not be found sufficiently durable after scratch-brushing, a second or third coat may be applied. This silvering is not so adhering on white or pure copper as upon a gilt surface.

For the reflector of lanterns the paste is rubbed upon the reflector with a fine linen pad; then, with another rag, a thin paste of Spanish white or similar substance is spread over the reflector and left to dry. Rubbing with a fine clean linen rag restores the luster and whiteness of the silvered surface.

The paste is sometimes mixed directly with the whiting and left to dry, or until nearly dry, then rubbed down as described.

Sil'ver-ing Glass. Prepare two solutions, says the "*Jeweler and Silversmith*": —

1. Argentic nitrate is dissolved in distilled water and ammonia added to the solution, till the precipitate first thrown down is almost entirely redissolved. The solution is filtered and diluted so that 100 cc. contain one gram of argentic nitrate. 2. Two grams of argentic nitrate are dissolved in a little distilled water and poured into a liter of boiling distilled water; 1.66 grams of Rochelle salt is added and the mixture boiled for a short time, till the precipitate contained in it becomes gray; it is then filtered hot.

The glass having been thoroughly cleaned with (1) nitric acid, (2) water, (3) caustic potash, (4) water, (5) alcohol, and lastly, distilled water, is to be placed in a clean glass or porcelain vessel, the side to be silvered being placed uppermost. Equal quantities of the two solutions are then to be mixed and poured in, so as to cover the glass. This should be done while the glass is still wet with distilled water. In about an hour the silvering will be completed. Then pour off the exhausted liquid, carefully remove the glass, wash in clean water, rub off silver deposited where not required, allow to dry and varnish silver side with any thin varnish which does not contract much in drying. The time required for the operation depends on the temperature. If the solution be warmed to about 30° C., the silver is deposited in a few minutes, but it is safer to use them cold. The insides of test-tubes, bulbs, etc., are silvered by putting the solutions into them, no second vessel being then required. Throughout the whole operation the most scrupulous cleanliness is the grand essential.

Furnace, *Stetefeldt* . . * "*Min. & Sc. Press*," xxxiv. 349.
Silvering glass . . . . "*Scientific American Sup.*," 1928.
Laval . . . . . "*Scientific American Sup.*," 921.
Ivory . . . . . "*Man. and Builder*," xii. 167.

Sil'ver-ing Mir'rors. Some time since the Academie des Sciences offered a prize of 2,500 f. for a method of satisfactorily and permanently silvering mirrors, and which should save the workman the danger of exposure to the effect of mercurial vapors. The prize has been awarded to M. Lenoir, whose process is substantially as follows: —

The glass is first silvered by means of tartaric acid and ammoniacal nitrate of silver, and then exposed to the action of a weak solution of double cyanide of mercury and potassium. When the mercurial solution has spread uniformly over the surface, fine zinc dust is powdered over it which promptly reduces the quicksilver and permits it to form a white and brilliant silver amalgam, adhering strongly to the glass, and which is affirmed to be free from the yellowish tint of ordinary silvered glass, and not easily affected by sulphurous emanations.

Silvering mirrors . . "*Scientific Amer.*," xli. 232; xliii. 73.

Sil'ver Pro'cess. The plan of Paul's dry-process mill, for working gold and silver ores, is —

1. The calcining furnace; 2, the self-feeder; 3, the stamp battery; 4, dust casing; 5, elevators (these are not used when the ground admits of the battery being set on a level with the pulverizing barrel; 7, hopper for pulverized ore; 8, amalgamating barrel; 9, hopper for conveying ore to the settler; 10, first settler; 11, amalgam safe; 12, hydrostatic settler; 13, concentrator.

The ore is reduced to powder by attrition of quartz, and the amalgamation is speedy. Ore is passed into self-feeders, and that is the last of the handling. The gold contained in it will be found in the amalgam safe, all ready for retorting. The machinery is ingeniously constructed, and works effectively. It is rendered perfectly automatic, so that, from the moment the quartz is put into the feeder until the gold comes from the machine in the shape of amalgam, the stuff is not handled. Only two men are necessary to run a 10-ton mill.

Sil'ver Steel. (*Metallurgy.*) A steel of fine quality with a slight alloy of silver.

Sil'ver Ware. Table ware made from or coated with silver. See CHASING; REPOUSSÉ; SNARLING; GILDING, etc. "*Mech. Dict.*"

Silver ware . * "*Scientific American*," xxxvi. 287, 291, 292.

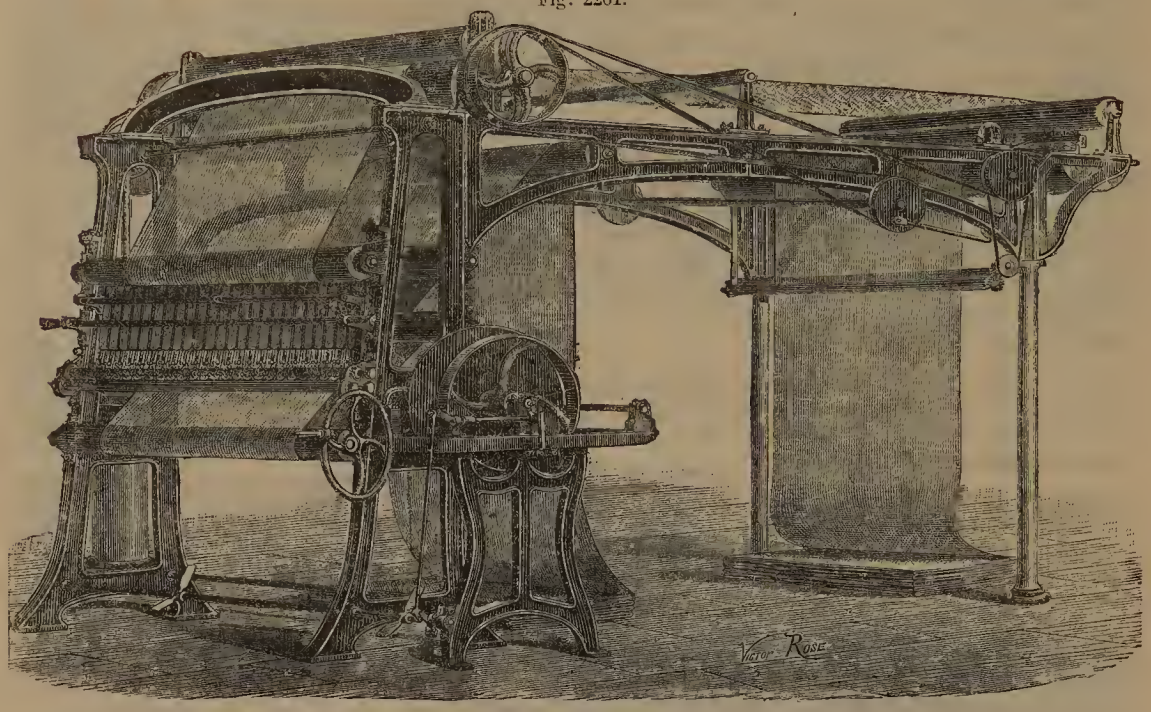
Singe'ing Ma-chine'. A gas singeing machine intended for removing or dressing the nap on woven goods.

In Fig. 2261, the workman has the work directly under his notice, and can vary at any time the intensity of the flame, or the speed at which the cloth is traveling.

The burners are so arranged that the application of compressed air takes place at the moment of the combustion of the gas, and by varying the pressure of the air all the different degrees of heat can be obtained, and thick and thin fabrics singed with equal facility. The upper part of the burner is open along its whole length, and cocks and other means are provided for regulating the line of flame, so as to make it perfectly even, or to reserve, if required, certain parts of the surface of the cloth from the action of the flame. The position of the line of flame can also be varied according to the effect which is required. Thus the flame applied directly under the roller singes the cloth thoroughly, and, it is said, brings out the grain, as is necessary in merinos, cashmeres, etc.; but in the case of delicate tissues, where it is necessary simply to dress the cloth lightly as with a shearing machine, the line of the flame is placed tangentially to the roller, and only takes off the projecting fibers.

The workman can, by means of a treadle, instantly stop the feed of the cloth, and at the same time reverse the line of flame so as to suspend its action; thus fringed shawls can be singed and accidents easily avoided.

Fig. 2261.



Gas Singeing Machine.

This system produces no smoke or soot, so that the most delicate tissues can be singed without altering the color, and after bleaching, dyeing, or printing, without changing the shade.

The mixture of compressed air and gas is effected, so as to produce great economy in gas, and at the same time a great intensity of flame. The intensity of the flame is increased by augmenting the pressure of the air without varying at all the quantity of gas, which latter only becomes then more perfectly consumed.

The general arrangement of the machine with a single flame, as usually made, is clearly shown in the above drawing, but machines are also arranged, when desired, with two or four flames so as to singe both sides of the stuff at one passage.

Sin'gle Coil Spring. One made of a single spring wire, coiled upon itself, with same diameter throughout.

Sin'gle Flu'id Bat'ter-y. (*Electricity.*) A term used for the battery with but a single fluid, in the double fluid battery invented by Daniell. See p. 2187, "*Mech. Dict.*"

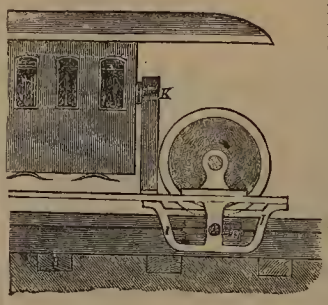
Air as a depolarizer in a single fluid cell is found in
Pulvermacher's . . * "*Telegraphic Journal*," vi. 388.
"*Engineer*," * xlvi. 143.
"*Scientific Amer. Sup.*," 2213, 2247.
Pulvermacher, Fr. * "*Engineer*," xlvi. 143.

Sin'gle Plate Wheel. (*Railway.*) A car wheel which has a single plate between the hub and the rim. The plate or disk is sometimes flat, or ribbed on one side, or corrugated.

Sin'gle-rail Rail'way. One in which the cars are supported and run on a single rail, and are braced or steadied by side-rails.

Figs. 2262, 2263 show the details of construction of a new and improved car for single-rail railways, invented by David B. James, of Visalia, Cal. The invention consists of one line of broad-faced wheels in the center to carry the load, and guide wheels to run each side of the rail on vertical axles projecting down from the car, these wheels being to keep the carrying wheels on the track and to prevent the cars from overturning, for which they are contrived to gripe the rail with more or less force. The wheels are connected with a platform which is carried only enough higher than the rail to clear it properly, and the car is mounted on pivots arranged in the line of the wheels, and supported on the platform so that the load is balanced on the wheels, and the center of gravity is lowered as much as possible to prevent overturning. The guide wheels running against the sides of the rails are contrived to move forward and from the rail, and provided with springs to keep them in contact. In the locomotive they may be geared with the power and have a lever contrivance for gripping the rail tightly for traction on steep grades.

Fig. 2262.

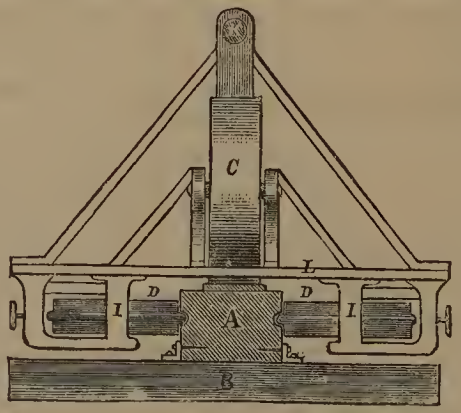


Single-rail Railway.

Fig. 2262 of the engravings is a longitudinal section elevation of the improved railway car, showing the guide wheels, ridged and running in a groove in the stringer. Fig. 2263 is a horizontal section, giving an end view of the car and track, stringer and ties, with side wheels, the ridges in which fit into the groove in the stringer.

In the engraving, *A* is the single rail, of wood, which may be of a single timber, or it may be shod on top with another, to be removed from time to time when worn, the removable

Fig. 2263.



Single-rail Railway.

one being, say from 2″ to 3″ thick. *B* represents the ties, which may be of any suitable kind. *C* represents the

carrying wheels of the car; *D*, the wheels for guiding it, and preventing it from overturning, the latter wheels being mounted on vertical axles *F*, projecting down from the car body or supports, *I*, so that the wheels run against the edges of the rail, while the wheels *C* run on top. The axles *F* are mounted in bearings *G*, which are movable toward and from the rail, and have springs to press them against it, by which they are accommodated to variations in thickness of the rail, and allow the car to turn curves readily, without requiring the wheels *C* to be mounted on a pivot or fifth-wheel.

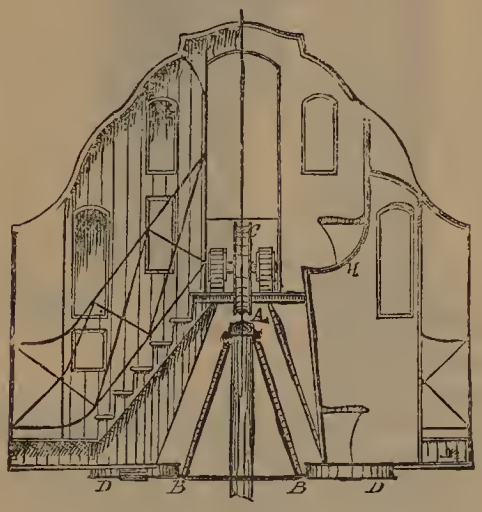
The car body *J* is mounted on the pivots *K*, supported on the platform *L*, which is suspended from the axles of the wheels *C*, the said pivots being arranged in the longitudinal plane of the wheels *C*, so the center of gravity of the load remains more on the wheels than it otherwise would, and the car is more certain of keeping erect in case the load is not trimmed nicely, or the car is jarred or otherwise forced laterally. But to prevent the car from rocking too much on the pivots, and also to prevent it from striking too hard on the platform in case it does rock, buffer springs *M* are attached to the under side of the car body, so as to strike the platform, or they may be applied so that the body may strike against them.

The platform will always run level on account of using only one rail and employing the guide wheels to direct the car, which avoids the necessity of tilting the car as on the curves of the roads of two rails, and thus the difficulty of carrying the cars upright on a single track is greatly diminished.

If considered necessary, the carrying wheels may be banded with rubber to prevent wear of the wood rails, and for running smoothly, but it is believed that the broad surfaces will wear so little as not to need it. By gearing the guide wheels of the locomotives with the driving wheels, and employing levers to cause them to gripe the rails, very steep grades may be ascended. Very abrupt curves can easily be overcome by means of this system, as well as steep grades. The engineering difficulties of a line in a mountainous country could therefore be overcome by it, as a narrow-gauge road overcomes the difficulties of a broad-gauge under such circumstances. The stringer is fastened to the ties with iron knees.

Figs. 2264, 2265 show a road that consists of a single bearing-rail, *A*, of the common T rail pattern laid upon a wooden stringpiece of about 4 × 8 timber, which rests upon the top of a row of posts, or piers, and is flanked by a pair of side rails, *B B*, which are dropped some 4′ 5″ below the level of the bearing rail *A*, and are 3′ 4″ from out to out. A system

Fig. 2264.



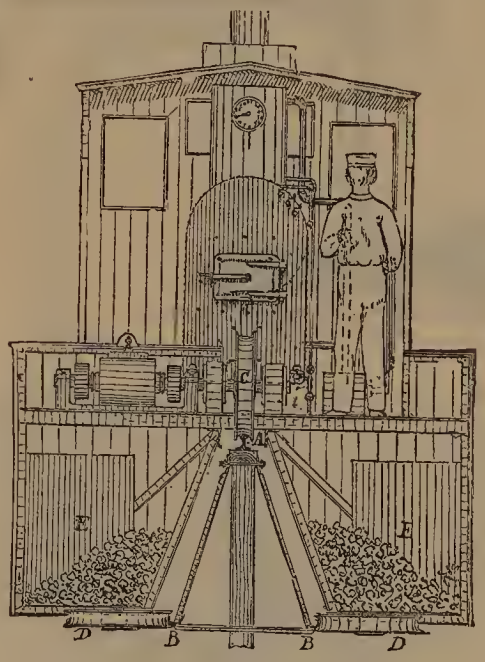
Single-rail Railway

of cross bracing from the main rail *A* to each of the side rails, supplemented by a similar set of braces between the rails *B B*, gives the whole the character of a triangular truss, of great strength in proportion.

The locomotive used on this road, of which Fig, 2265 is a rear view with casing removed, runs upon two driving-wheels shown at *C C*, of 28″ diameter; the boiler, of the style known as "locomotive," 12′ long and 34″ in diameter, with 4½′ fire-box, is dropped as low to the bearing-rail *A* as practicable. The frame of the locomotive is made of angle iron, and drops to the level of the side rails *B B* on either side, carrying on each side two guide-wheels *D D*, of 28″ diameter, which run upon vertical axes. Both the driving-wheels *C C* and guide-wheels *D D* are grooved, or, properly speaking, double-flanged, making it impossible for the locomotive to be taken off the track by any accident that does not first actually take the wheels off, and then lift the machine bodily nearly 5′, throwing sideways with al. The total length of the engine is only about 17′. The fuel and water tanks being below the level of the bearing-rail and upon the side-frames, assist in ballasting and steadying the machine. The engines proper are of the La France rotary pattern, the principle of which is that of two gear-wheels running in a tight case.

The road, as shown here, is designed for city and rapid transit where the height above the ground, as well as the length of the span between supports, is necessarily great, but for country roads a much simpler and more economical style of construction is recommended, wherein the roadway consists of a single bearing-rail *A* of iron, the side-rails *B B* being of hard wood, and the side-plates that support *B B* are brought together near enough to bolt directly to the posts,

Fig. 2265.



Single-rail Railway.

which should be of cedar. A road of this kind, capable of carrying a load of four tons per bearing-wheel, is estimated upon as follows. For each mile in length the company estimates: —

Steel bearing-rail, 40 lbs. per yard, at $65 per ton	$1,242.00
Splice-plates and spikes	135.00
Stringpiece 8 × 10, side-plates 5 × 6, side-rails 3 × 4, all of hard or Georgia pine	1,700.00
Lag bolts, plate bolts, and spikes	160.00
Cedar posts, 8″ in diameter, 12′ long, 550 per mile at $1	550.00
Setting in concrete base, 25 cents per foot	137 50
Mill work, squaring ends and boring bolt holes	250.00
Contingencies	325.50
Total	$4,500.00

The above figures are obtained with reference to the south-eastern part of New Jersey, where the soil is sandy; but it is to be remembered that in no case is any amount of grading or earth work to be allowed for, no culverts to provide: the only difference required by small streams is a slight increase in length of posts perhaps (and this is the better rule for crossing all highways and railroads), also an increase of elevation and span, requiring only a little more lumber at such points to reënforce the stringer plates and posts, and no other extra expense; swamps or peat-bogs may require some crib work, but again it is only a call for more cedar, and nothing else. Such a roadway should only need renewal in from fifteen to twenty years. The bridging of highways and streams adds little or nothing to the first cost. The single bearing-rail is about 5′ from the ground as a minimum.

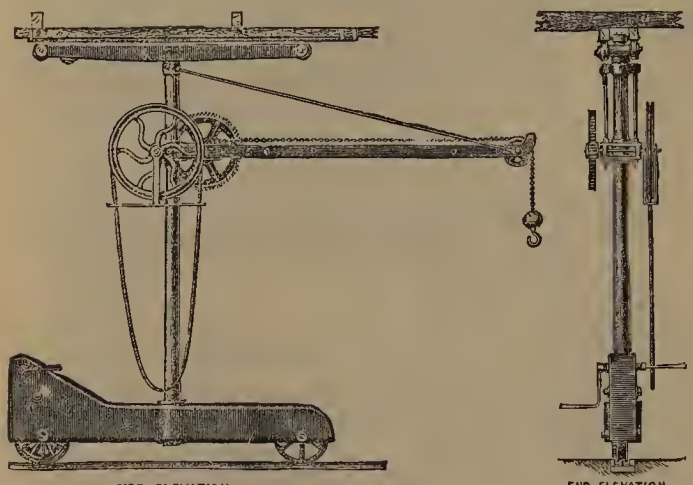
Single rail	* "*Sc. American Sup.*," 511, 694.
Uno-rail	* "*Mech. Dict.*," Figs. 1210, 6872, pp. 513, 2683.
Palmer	"*Mech. Dict.*," Fig. 1856, p. 792.
Baker	"*Iron Age*," xix., Feb. 8, p. 15.

Sin'gle Screw Turn'buck-le. A link hav-

ing a nut at one end and a swivel at the other, used in lightning-rods. See TURNBUCKLE, *c*, Fig. 6794, p. 2659, "*Mech. Dict.*"

Sin'gle-rail Crane. A single, mounted rail carrying a crane for shifting to different parts of a room.

Fig. 2266.



Single-rail Crane.

This form of crane, shown in Fig. 2266, is for hand-power, but the general form is the same whether the crane is worked by hand or is driven by a high-speed cord or tumbler shaft. The under-carriage or bogey is fitted with two double-flanged wheels, one in front of the other, and traveling on a single rail, which is usually sunk so as to be flush with the floor, in order not to interfere with the free circulation of foot or wheeled traffic in any direction; the stability of the crane is maintained by the post being keyed securely into the carriage, its upper end being fitted with a horizontal wheel which works between a pair of guides fixed to the under side of a floor, or to the beams or columns; these guides are fixed in the same line as the single rail on the floor and plumb above it, and extend the full length that it is desired to travel the crane; the jib is hung on a shoulder on the post; the thrust of the jib being taken by a pair of friction rollers working against the post; it therefore turns very freely entirely round the post. The gearing is worked from the floor by hauling on the endless hand-rope, and the barrel-shaft is fitted with a self-acting arrangement, which maintains the load suspended directly the hand-rope is released. One of the traveling wheels is geared up to the handle shaft on the carriage, which is the proper height from the ground for easily turning.

It will be evident from the engraving and the foregoing short description that these cranes occupy so little space that they are peculiarly adapted for running between two lines of lathes or machine tools, or for lifting the smaller parts of machines in the erecting shop after the heavy portions have been put in position by the overhead traveler. Cranes of this type have been constructed for many of the leading engineers; they are also usefully employed in wool warehouses or furniture stores where goods are packed from floor to ceiling. For the platforms of railway or dock goods sheds this system affords very great facility for concentrating the crane-power at any given point, and the heavy outlay is avoided for a number of fixed cranes which can neither be always employed nor cover the ground so completely as portable cranes. These cranes lift a load and swing entirely round with it, or travel with it as readily as if it were on a truck on rails.

Sin'gle Shear Steel. (*Metallurgy.*) Blister steel, once reworked by heating, rolling, and tilting to improve the quality.

Sin'gle Whip. (*Nautical.*) A simple form of tackle formed by reeving a rope through a single block. *a*, Fig. 7196, p. 2770; *a*, Fig. 6159, p. 2480, "*Mech. Dict.*"

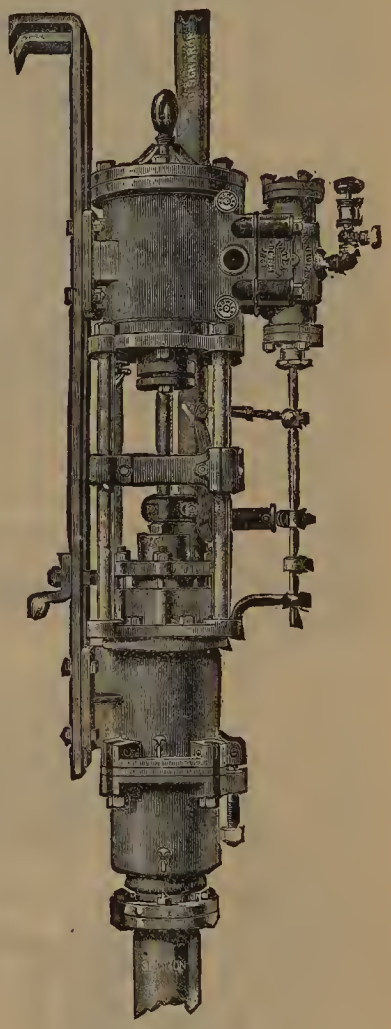
Sin'glings. The first to come over, the crude spirit of distillation.

Sink'er Bar. A medium length section of a long boring rod or auger stem for sinking shafts. A still shorter section is called a *substitute*.

Sink'ing Pump. A vertical pump adapted to sinking new shafts and recovering abandoned mines.

The pumps are of various capacity. The one here illustrated (Fig. 2267) is next to the smallest made, weighs one thousand pounds, and has a capacity of about eighty gallons per minute. It is built on the bucket-plunger plan, adapting it to gritty water. The removable barrel admits of easy renewal when worn, and swing-bolts give access to both pump-barrel and water-valves. It is also through its attachments made adjustable to the water level.

Fig. 2267.



Sinking Pump.

Fig. 2268.

Sinus Probe.

Si'nus Probe. A vermicular pointed uterine curved probe, used in its peculiar branch of surgical operations. Fig. 2268.

Si'phon. A unique application of the siphon, to enable the transmission of water over higher levels than its source, is described as follows: —

The most remarkable illustration of this principle on a grand scale is to be found at the water works at Virginia City, Nev. The water is brought in an 18″ flume, 4 miles long, to a spur overlooking the Washoe Valley 2100′ above the Truckee Railroad track. There it is received into an iron pipe which after descending into the valley ascends on the other side to the height of 1,540′.

The length of the inverted siphon is nearly 7 miles and conveys two million gallons of water per day. The leading of such a stream of water across such a valley has no parallel in hydraulic engineering. The pressure on the pipe is equal to a column of water 1,720′ high. The orifice of the pipe is 12″ in diameter, and the amount of rolled iron used in its manufacture is 1,150,000 pounds. A million rivets were used in its construction, and 50,000 pounds of lead in fastening the joints. The line of pipe is compelled to twist

and curve to fit the inequalities of the ground and crosses 13 steep cañons. At the bottom of each depression a blow-cock is used to remove the sediment, and at each elevation is an air vent. The water when received into the pipe from the flume passes through wire screens and charcoal.

Stillwell . . . . . * "*Scientific American*," xxxv. 307.
Automatic, *Taylor* . . * "*Scientific American Sup.*," 2717.
* "*Scientific American*," xl. 216.
Condenser, *Sault*, Br. . * "*Engineering*," xxii. 484.
Lubricator, *Weatherburn*, Br. . . . . * "*Engineer*," xlv. 170.
Overflow, automatic. *Taylor*, Br. . . . . * "*Engineer*," xlvii. 353.
Recorder, *Thomson*, Br. * "*Engineering*," xxii. 115.
Verdon canal, across valley of St. Paul, Fr. . * "*Engineering*," xxiii. 246.

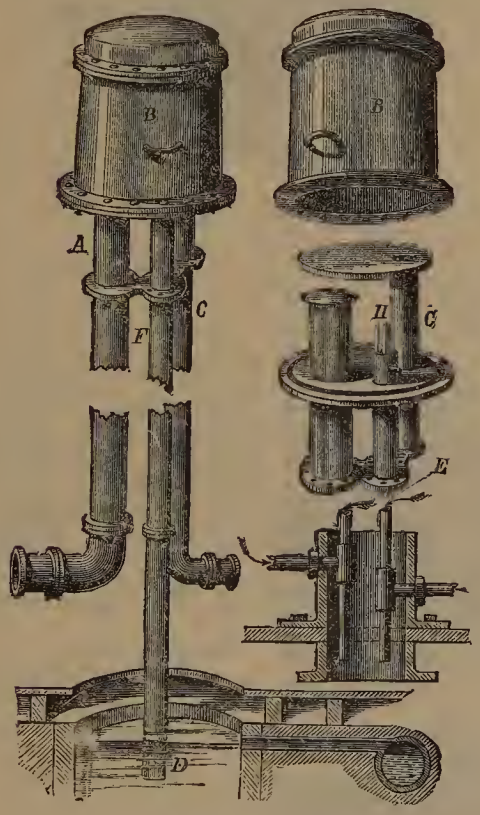
Si'phon, Au'to-mat'ic. A siphon the short arm of which being provided with a valve is actuated and set in motion by the alternate vertical movement given to it.

It is operated without withdrawing the air by suction, through the inertia and adhesion of the liquid.

Si'phon Con-den'ser. An ingenious device for producing a siphon vacuum, profitably employed in a low-pressure engine as a substitute for the air-pump and condenser.

The condenser is placed on top of a vertical tube (say 34′ to 40′ high) that has its lower end inserted in the hot well.

Fig. 2269.



Siphon Condenser.

Connected also with the condenser are the tubes that convey the exhaust steam from the engine on the one hand and the ordinary injection of cold water on the other.

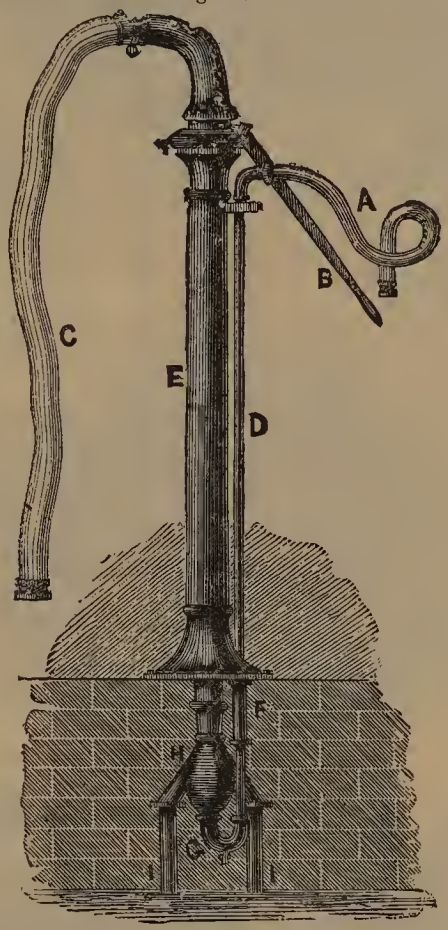
Si'phon Gage. (*Gas.*) A form of gage used in determining the pressure or vacuum in gas pipes. It consists of a convolved pipe in the U of which is a liquid acted upon by the gas admitted by a pipe. The zero in the graduated member is when no pressure is exerted and the liquid is at an equal height in each leg. Below and above this are graduations which indicate inches of water pressure or vacuum.

Si'phon Pipe. A curved pipe that on the principle of the siphon conveys liquids over inequalities in its track.

Si'phon Pump. A device for raising water by the direct action of steam. It combines the powers of a force and lift pump without piston, plunger, valve, or any movable parts, so as to have little about it to wear or get out of order.

Solid bodies of less diameter than the pipes of the steam siphon pass through it without obstruction, thus drawing up and ejecting mud, sand, cinders, fruit, grain, chips, coal, etc., that with a common pump would obstruct the valves. Fig. 2270.

Fig. 2270.



Siphon Pump.

Si'phon Re-cord'er. A delicate recording instrument for the receiving end of submarine cables, the invention of Sir William Thomson.

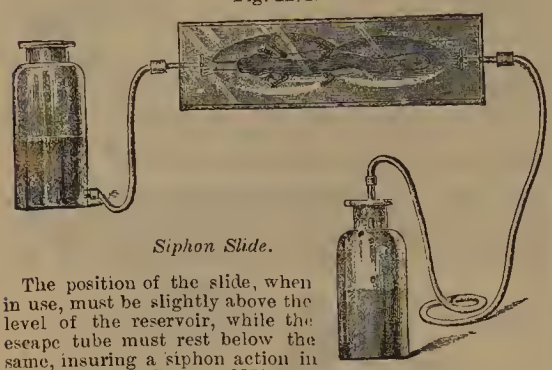
It has a large magnet with a small movable coil of wire (in the line circuit) suspended between its poles; when a current passes the coil moves, and this movement in the magnetic field is communicated to the siphon pen which thereupon writes the message. The letters consist of a codified series of right and left deviations from the right line, due to the movement of the paper by the mechanical feeder.

"*Engineering*" . . . * xxii. 115, 116.
"*Sc. American Sup.*" . * 205, * 909, * 4060.
Paper by *Ewing* . . . * "*Jour. Soc. Tel. Eng.*," v. 185.

Si'phon Slide. A device for the retention of small aquatic animals in a position suitable for experiment and observation.

In a slip of thick plate glass a chamber is excavated that has at each end fine perforations, too small to permit the escape of the animal under view, but sufficient to maintain a flow of water. These openings emerge into tubular mouths, to each of which is attached a tightly-fitting elastic tube; one of these communicates with a reservoir of [illegible]r, whilst the other acts as an escape conduit.

Fig. 2271.



Siphon Slide.

The position of the slide, when in use, must be slightly above the level of the reservoir, while the escape tube must rest below the same, insuring a siphon action in the apparatus. See Fig. 2271.

Si'phon Tel'e-graph Re-cord'er. See SIPHON RECORDER.

Si'phon Trap. One in form of siphon to prevent the rising of gases from sewers, etc. See SEAL; SEWER-GAS CHECK, *supra*, and Fig. 6618, p. 2617, "*Mech. Dict.*"

Si'ren. 1. An apparatus for detecting the sonorous qualities of various kinds of wood and metals.

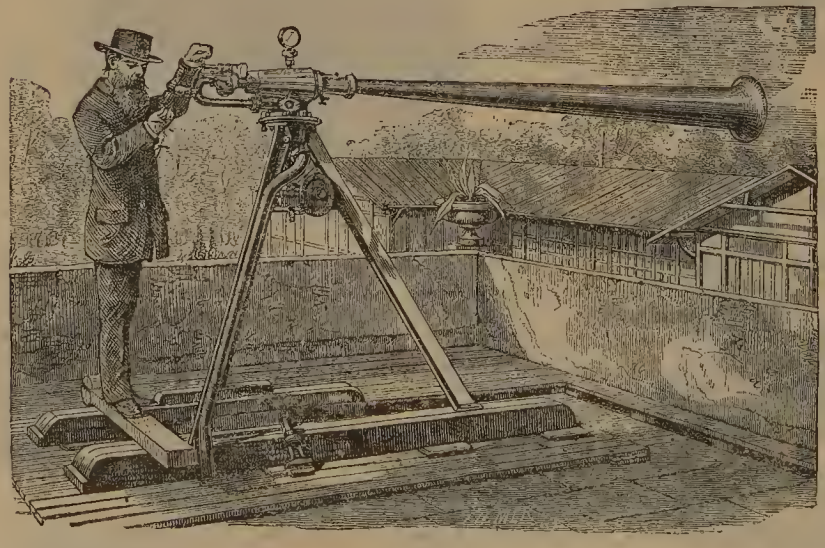
2. An instrument for producing musical tones and for measuring the intonations and vibrations of sound-waves.

For comparison of the Daboll fog trumpet, siren, etc., see "*Smithsonian Report*," 1878, by Prof. Henry, pp. 455–559.

In the grand siren of Lubec a strong system of clock-work keeps in motion a copper disk, pierced with holes at regular intervals. A common air-chamber communicates with a series of tubes that can be accurately adjusted in front of the revolving disk, at any required position. A registry gives the velocity of rotation.

Four of the disks are intended to show the results obtained when the isochronism of the impulses is imperfect from any cause; the fifth shows that impulses coming from different points can unite to form one sound; the sixth serves for experiments on interference; the seventh has eight series of holes, giving the gamut; the eighth has eight series of holes

Fig. 2272.



Siren.

for the harmonics, and the ninth illustrates the phenomena of beats. See also Helmholtz's Double Siren and Oppelt's Siren.

The Centennial Steam Fog Siren or Trumpet and the Austrian fog trumpet are different modifications of instruments intended to denote points of danger to shipping in times of dense fog.

About seventy pounds pressure of steam is employed. As the rotating disk rotates rapidly puffs of steam escape, and as these vibrations quickly succeed each other a sound of great intensity is produced, the pitch of which depends upon the rapidity with which the puffs succeed each other, or upon the velocity of rotation of the disk, precisely as in the acoustic instrument called the siren, used in physical apparatus to illustrate the truth that the pitch of a sound depends upon the number of aerial vibrations produced in a given time. This steam siren has been experimented upon by Professor Tyndall in his recent investigations upon the propagation of sounds through fogs and under other atmospheric conditions, and has proved very far superior to artillery in signaling through fog. See Fig. 2272.

Comparison of the Daboll fog trumpet and siren and other matters in "*Researches in Sound*," "*Smithsonian Report*," 1878, by Prof. Henry, pp. 455–559.

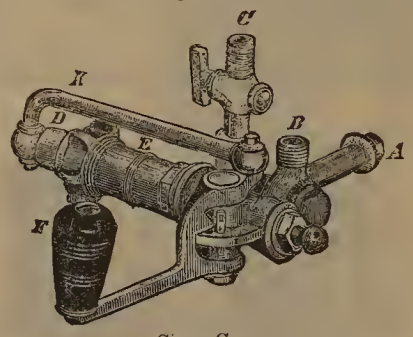
* "*Scientific American Sup.*" . . . . . 766.

See SIREN, Fig. 5114, p. 2191, "*Mech. Dict.*"
See FOG TRUMPET, Fig. 1080, p. 353, *supra.*

Siren . . . . . * "*Engineer*," xli. 46.
Buoy, self acting.
Courtenay, Fr. . . * "*Engineering*," xxvii. 510.
Compressed air, *Sautter Lemonnier & Co.*, Fr. . . . . * "*Engineering*," xxx. 366.
Irish, *Wigham* . . . "*Scientific American Sup.*," 2398.

Sir'up Gage. The solid plunger sirup gage, illustrated in the accompanying cut, is a device in-

Fig. 2273.



Sirup Gage.

vented by John Matthews, of New York, for delivering a fixed quantity of sirup and carbonade into bottles at the bottling machine.

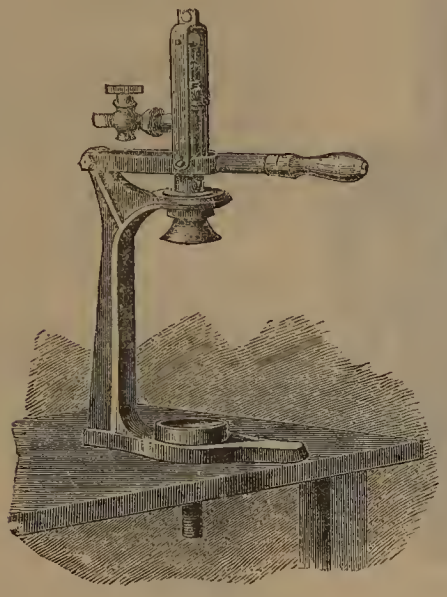
The sirup is admitted to the pump through the inlet *C* and the carbonade enters through the inlet *B*, the mixture passing out to the bottling machine through the outlet *A*. The solid plunger *D* works in the cylinder of the pump *E*, and is operated by means of the handle *F* and the connecting rod *K*. The stroke of the plunger is regulated by means of the pin *H*, which enables the quantity of sirup delivered to the bottle to be accurately gaged. *I* is a guide for the crank which operates the solid plunger.

Sir'up Pump. A device for measuring sirup into soda-water bottles. The pump being secured to the bottling table, the bottles are charged with sirup and passed under the bottling machine. See Fig. 2274.

Sir'up Tank. For soda water.

In the cut (Fig 2275) is illustrated the portable measuring sub-lift sirup tank invented and introduced by John Matthews, of New York, for use in soda water dispensing apparatus. The glass tank *E* is provided at its lower extremity with a measuring chamber, *S*, and at its upper extremity, with two orifices. Through one of these orifices passes the rod *Y*; the other is intended for filling the tank. The rod *Y* is provided at its lower end with two valves, and at its upper end with a grooved cap, *Z*, into which fits the upper extremity of the lifting bar *V*. Through the rod *Y* runs an opening, *U*, for venting the measuring chamber. *K* is guide for the lifting bar, and *X* is a button on the lower

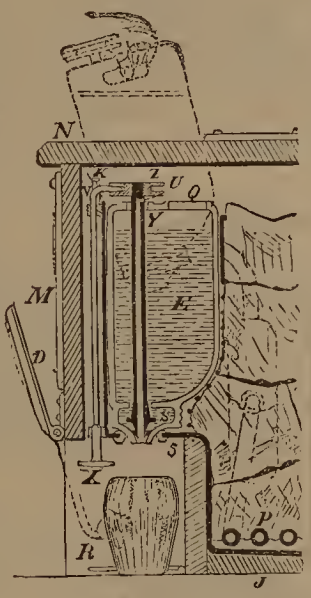
Fig. 2274.



Sirup Pump.

extremity of the bar. The operation of the sirup tank is as follows: When the valve-rod *Y* is at rest, the lower valve on its extremity rests on the lower valve-seat of the measuring chamber. The sirup is now prevented from escaping into the glass, but is admitted from the tank to the measuring chamber. If now the button *X* be raised, either by the hand or by the glass, the valve-rod *Y* will likewise be raised until the upper valve is brought into close contact with the upper valve-seat of the measuring chamber. This will allow the sirup in the measuring chamber to follow into the glass, and will prevent the further admission of sirup into the measuring chamber. The removal of the tank from the apparatus may be effected by raising the guide *K* and turning the lifting bar *V*. The tank can then be taken out as shown by the dotted lines.

Fig. 2275.



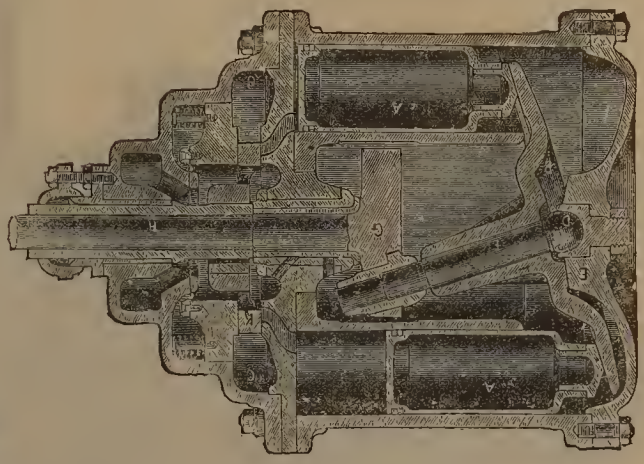
Sirup Tank.

Six-cant'ed File. Has an angle of 120°, and is used for hexagonal nuts, wrenches, etc.

Six-cyl'in-der En'gine. The engine consists of a base-plate carrying a casting containing six cylinders arranged in a circle. The axes of the six cylinders are all parallel to the main shaft, which traverses the middle of the casting. A light hollow piston works in each cylinder, each piston having a conical end that bears against a disk. The disk is mounted on a short shaft, having at one end a spherical bearing, while at the other end enters a brass bush fitted to the crank-arm that is keyed to the main shaft.

The pistons are single-acting, the pressure of steam in the cylinders tending always to force them against the disk. The shaft makes one revolution for each complete double stroke of each piston, and as each acts during the same revolution, the six going into operation successively at intervals of 60°, it follows that three pistons are constantly acting on the disk. The strain thus thrown upon the crank and shaft is practically uniform, and there being no dead point, no fly-wheel is necessary. It balances itself. See Figs. 2276, 2277, 2278, 2279, which with the description explain themselves.

Fig. 2276.

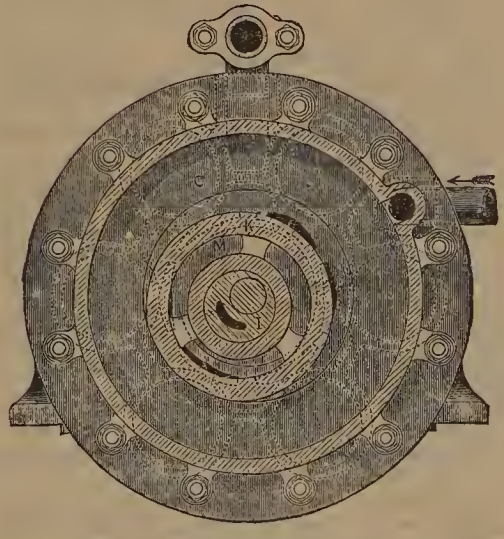


Six-cylinder Engine.

Fig. 2277.

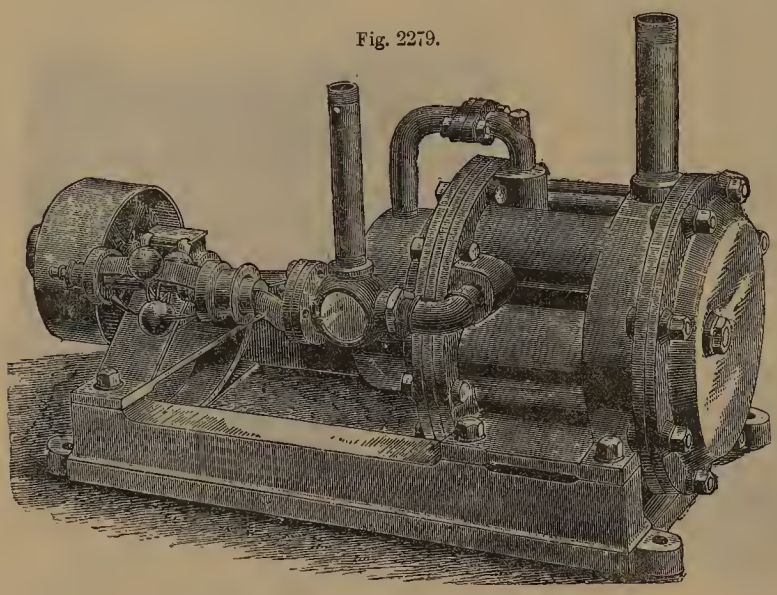
Six-cylinder Engine.

Fig. 2278.



Six-cylinder Engine.

Fig. 2279.



Six-cylinder Engine.

Six-cylinder engine, *West*	* "*Engineer*," xlii. 411.
	* "*Engineering*," xx. 28.
West, Br.	* "*Engineering*," xxii. 511.
Applied to Gramm machine	* "*Engineer*," xlv. 55.
Six-coupled locomotive.	* "*Engineer*," xlvi. 135.
* "*Iron Age*"	xxi., Feb. 21, p. 1.
* "*Scientific American Sup.*," . .	923.

See also DISK ENGINE, Fig. 1666, p. 708, "*Mech. Dict.*"

Six'fold Knot. A knot in which one part is wound 6 times around the other before jamming.

Siz'ing. (*Leather.*) A paste made of flour, soap, beeswax, a little linseed oil, and water. It is applied to the grain side with a sponge. It fills the pores and serves to give a smooth finish to the leather.

Sizing cotton goods.	
Thompson	"*Scientific American Sup.*," 1269.
Sizing, history of. . .	"*Scientific American Sup.*," 2868.

Skein Screws. A screw with a shallow open thread.

Skein Set'ter. A machine for fitting metallic skeins to wooden axles. See Figs. 148, 151, pp. 61, 62, "*Mech. Dict.*"

Skein Tor'sion Ma-chine'. A machine for twisting silk while under tension. See SILK SOFTENING MACHINE.

Skel'e-ton Bell. An electric call and alarm bell used on railroad trains and other places where such communication is desired from distant points. Such as are peculiarly adapted for railroad trains have a lock attachment preventing any movement of the bell-hammer till it is actuated by the magnets. One variety is made with a continuity attachment causing the bell to continue ringing several seconds after the current on the line wire has ceased, making it useful when a prolonged call is desired.

Skel'e-ton Rol'ler. (*Agriculture.*) An open ribbed roller used in France. The open bars of the drum enable it to answer in a degree the same purpose as the English clod crusher.

Skew'-back. A casting on the end of a truss, to which a tension rod may be attached. It may form a cap, or be shaped to fit the impost.

(*Blast-furnace.*) A ring formed on the inside of the wall of a blast furnace, opposing the descent of stock by diminishing the sectional area at that point.

If sufficient heat gets above the fusion limit of a blast furnace to paste the stock and yet not fuse it, this stock jams on the bosh, forming a ring which if the stock above cannot push it down to the fusion limit, allows this ring to become permanently set and so obstruct the flow of stock.

* "*Iron Age*" . .	xxv., March 4, p. 3, Fig. 4.

Skim Net. (*Fishing.*) A large dipping net.

Skin Graft'ing In'struments. (*Surgical.*) The principal special instruments which are used in the transplantation of skin are —

Skin grafting scissors.
Cutisector.
Epilating forceps.
Glass pleximeter.
Scarifying spud.
Milium needle.
Sharp spoon.

Page 11, Part V., *Tiemann's* "*Armamentarium Chirurgicum.*"

Skit'tle Pot. A crucible taking the shape of a skittle, smaller below and bulging towards the top, again contracting at the rim.

Ski'ving. (*Leather.*) The act of removing the rough fleshy portion from the inner surface of a skin by the currier driving his knife obliquely a few inches at a time, and keeping the right hand slightly in advance of the left in the downward motion.

Skiver	* "*Scientific American Sup.*," 101.

Slab'bing Ma-chine'. A tool especially adapted to mill the flats of connecting rods and similar work. It is arranged with bed, tables, and uprights, like planer with a capacity of 25″ × 25″; table 12′ long and operated by a spiral pinion. Spindle to carry cutter $4\frac{1}{2}$″ diameter, 4″ wide, strongly geared, and adjustable to height.

The feed is variable between the extremes, and the table, which is adjustable by hand, has an automatic stop motion to throw out the feed at the end of the stroke. The fast and loose pulleys are 20″ diameter, 3″ face, and should make 114 revolutions per minute.

Slack Bar'rel. One for flour, sugar, cement, fruit, and what not, of a dry character. In contradistinction to *tight* barrel.

Slack Burn'ing Lo'co-mo'tive. See WASTE BURNING LOCOMOTIVE.

Hunt, Br.	"*Iron Age*," xx., Nov. 29, p. 20.

Slack Gas Fur'nace. Casson's new gas and hot blast furnace is applied to puddling furnaces. The coal used — screened slack — is supplied into a hopper and drawn down into the grate. Through the back of the grate it is blown by hot air drawn down from the increased sides of the nearest stack. Hot air is likewise taken in at both the top and bottom of the furnace, and makes its way to the exit of the gas from the gas furnace before it passes over the bridge of the puddling furnace, and the hot air fires the gas. The supply of air is under the control of the puddler and regulates the fierceness of the flame.

The puddling furnace is a double furnace having circular rotating beds that are actuated by mechanical rabbles.

Slag. Blast-furnace slags are usually double silicates of alumina and lime, but vary with the character of the ore, as when the lime is partially replaced by magnesia and oxide of iron, which colors the slag, and in excess is an indication of imperfect working of the furnace.

The glassy slag produced in blast-furnaces is very abundant, and many methods of utilizing it have been proposed. In the Cleveland iron district of England, from three to four millions of tons of slag are made annually. Bricks, paving-stones, slabs, panels, tiles, etc., are made from this material.

About 30 cwt. of slag is made for each ton of pig-iron. The annual accumulation of slag in England is estimated at 80,000,000 tons. Slag is too dark in color to be used for purposes requiring translucency.

At the Cleveland Slag Works, England, in accordance with Mr. Charles Woods's plans, the slag is run from the furnace into two different machines, one of which produces a coarse kind of shingle, and the other a fine sand. For making shingle the liquid slag is run direct from the furnaces onto a circular, horizontal, rotative table composed of thick slabs of iron, kept cool by having water circulated through them. The slowly revolving table carries the slag around to a certain point, when having become solidified, it encounters a stream of water that further cools it, and soon after it comes in contact with a set of scrapers that break it up and clear it off the table, delivering it into wagons placed below that convey it away.

For producing slag sand the slag is run from the furnace into a hollow wheel revolving upon a horizontal axis and fitted with iron buckets inside. A bath of water is maintained inside the wheel at the bottom, and is kept in a state of violent agitation by the revolving action. As the molten slag enters the body of water, it is immediately disintegrated and assumes the form of sand, the water taking up the heat from the molten slag and giving it off in the form of steam.

A constant flow of water is maintained into the machine, and the sand is separated from it and elevated to the top by the bucket plates that are perforated. The slag sand is next dropped into a spout, and thence finds its way into wooden wagons, by which it is conveyed to the slag works for manufacture into brick, etc.

See the following uses and applications: —

1. *Artificial Stone.* — The process of making artificial stone from furnace slag is carried on at the Cleveland Slag Works. It is composed of a wet mixture of —

Pulverized slag	2.5
Ground bricks	2.5
Portland cement	1.0

The mixture is run into molds for building blocks, mantels, cornices, caps, sills, steps, balusters, etc. It sets quickly, and the blocks are ready for use in a week.

2. *Bricks.* — Bricks are made by either of two machines. The slag sand is elevated from the tub, and, after screening to remove coarse pieces, is divided by a revolving measure on the outside and placed at the bottom of the hopper. From another hopper selenitic lime and iron oxide in powder is measured by a similar contrivance, and the two substances unite in the proportion of, sand, 10; lime, 1. The material then passes to a mill where it is incorporated, and thence to the brick molding machine. The production of the machine is 11,000 to 12,000 per day. The bricks, after 4 months' exposure, are said (Kirkaldy) to resist a crushing pressure of 9 tons, and at 3 years of 20 tons. This shows that the chemical combination requires time. The Moss Bay Iron Works (England) also make slag bricks. The slag is ground under edge-stones, then passed through mill stones. The powder is moistened, pressed, and molded into bricks, and hardened in the open air.

3. *Cement.* — The slags, rich in alumina, are preferable for cement, as the aluminate of lime is the principal hydraulic agent in cement.

Mortar is a mixture of slag and 10 per cent. slaked lime.

Cement has an addition of iron oxides. Ransome's cement consists of carbonate of lime, 2; slag sand, 1, burned together. The result gives a cement said to be 30 per cent. stronger than Portland cement.

Concrete is made of the coarse slag at a cost of about one fourth that of brick.

4. *Glass.* — Slags rich in silex are preferable for glass. At the Fenidon glass furnaces, in Northamptonshire, England, the slag is carried in tanks direct from the blast furnace to the glass furnace, there mixed with other materials and worked into bottles. The method pursued is that of Mr. Bashley Britten. The glass furnace is of the Regenerative order, and the tank receives a charge of 500 pounds of molten slag to a due proportion of sand and alkalies. The melted metal runs through a bridge to the working end of the tank, where there are five working holes. Ninety gross of wine and beer bottles are made per day.

5. *Harbor Works and River Walls.* — These can only be economically formed of slag when the works are near the water.

At the Barrow Works the slag is tipped into the sea to make fresh land for the works.

At the Cleveland Works 600,000 tons of slag per annum are used in the continuation of a breakwater and river walls.

6. *Paving Blocks.* — The slag is run into heated molds, and the block is removed and annealed. They are heavy and wear well. Paving blocks and slabs are employed for paving streets, footpaths, stables, coach-house yards, crossings, breweries, curbstones, and channeling.

7. *Pig Beds* — Slag was formerly granulated and the sand used for pig beds, but this was discontinued for technical reasons.

8. *Road Making.* — Slag was formerly broken up and used for road making in England, and is still largely so used in Silesia. Slag shingle, or coarsely granulated slag is used for road making and paths.

9. *Slag Wool.* — Furnace slag blown while hot into fine threads or filaments has been made at the Clove Furnace, Greenwood Iron Works, Orange Co., N. Y.

The slag is drawn from the furnace into an iron tank carried on a truck. The car is run on a railway to a position opposite one of the apertures in the wool house, which latter is lined inside with thin sheet iron. The slag drops upon a receiver in a small stream, steam is conveyed under the receiver, and as the slag drops it is met by the jet which blows it with great force into the wool house in very thin filaments. The effect of the steam is to detach the slag in small shot which furnishes the basis of the filament. The smaller the shot the finer the filament, so the glass must not be too hot and liquid. By adjusting the heat of the slag and the strength of the steam jet the eventual size of the shot may be reduced to 1-16″ and it is not necessary to separate it from the wool. The lightest wool ascends to the upper story, and is free from the residuary balls. This mineral wool being incombustible and of a fine texture is a good non-conductor of heat, and is employed as a coating for steam boilers, pipes, cylinders, etc. It is called slag wool in England, and silicate cotton in Germany. It is used in Austria for making show cloths, laces, and fancy articles. It is also used in the manufacture of lanterns for electric lights. A patent has been taken out in Germany by Baatsch for the manufacture of prepared slag wool in order to prevent the generation of gases containing sulphur. The wool is placed in a wire netting and rapidly drawn through a dilute solution of water glass (1.2 to 1.3 specific gravity) and emptied on a floor coated with grease. The object is to wet only the surface of the wool without moistening the interior.

10. *Slag for Steam Pipe Insulation.* — Buttgenbach's method: Mix 150 parts of cinder dust, 35 parts by weight of fine coal dust, 250 parts of fire clay, and 300 parts of flue dust, with 10 parts of cow's hair, add 600 parts of water into which 10 to 15 parts of raw sulphuric acid has been poured, and make a stiff dough of the whole. This being applied in layers to the warm pipe hardens rapidly and is succeeded with future layers according to the thickness required. By the action of sulphuric acid gypsum is formed, and the silica rendered free hardens. The mass becomes as hard as porcelain and is still porous.

Slag, granulated for cement, railway ballast, casting bed, foundry molds, "*Iron*"	"*Van Nostrand's Mag.*" xiv. 476.
Slag block apparatus. *Woodward*, Br.	* "*Engineer*," xliv. 5.
Slag-brick machinery. *Wood*, Br.	* "*Engineering*," xxiv. 246.
Slag, uses of	"*Manuf. & Builder*," ix. 127.
Slag glass	"*Eng. & Min. Jour.*," xxx. 26.
	"*Engineering*," xxii. 274, 283, 321, 349.
Britten	"*Iron Age*," xviii., July 6, p. 24; Aug. 17, p. 11.; Oct. 26, p 3.
Slag, granulated, Fr.	"*Iron Age*," xvii., March 23, p. 3.
United States	"*Iron Age*," xvii., April 13, p. 15.
Slag and slag-wool pat.	"*American Man.*," Feb. 27, 1880, p. 13.
Slag paving blocks	"*Iron Age*," xviii., Nov. 2, p. 18.
Machine for making	* "*Scientific American Sup.*," 1362.
Slag utilization, Iron	"*Scientific American*," xxxix. 345.
Ward, Middleboro'	"*Iron Age*," xx., Nov. 22, p. 7.
	"*Scientific American Sup.*," 713.
Slag wool, Greenwood iron works	* "*Eng. & Min. Jour.*," xxv. 53.
	"*Iron Age*," xix., April 5, p. 7.
Machinery, *Wood*, Br.	* "*Engineering*," xxiv. 247.
Slag, furnace utilization	"*Min. & Sc. Press*," xxxvii. 151.

Slat Crimp'er. A machine used for sharpening, by compression, the ends of stationary slats to fit and fill mortises in the stiles.

The slats are placed in the vertical guides, and

are delivered sharpened, one with each revolution of the shaft.

Slate Roof. An economical system of covering buildings with large slates is as follows: The rafters are placed at a distance apart of $1\frac{1}{2}''$ less than the width of the slates. Down the center of each rafter is nailed a fillet, thus forming a rebate on each side, in which the edges of the slates rest, being secured by putty or by a second fillet 2″ wider than the first nailed over it, so as to cover the edges of the slates and hold them down. Each slate lays about 3″ over the one below it. Only half the number is required in this as compared with the ordinary method of slating, and no boarding or battens are necessary.

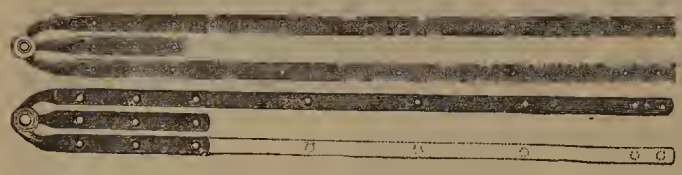
Slate dresser . . . . * "*Am. Man.*," Jan. 3, 1879, p. 12.
Slate quarry . . . . "*Scientific American*," xxxvi. 83.
Slate trim. and punching machine, *Davis*. . . * "*Scientific American*," xxxv. 34.
Slate washer, *Smith*. . * "*Scientific American*," xliii. 5.

Sla'ting. *Black-board Slating* may be accomplished with the following mixture: 10 ounces pulverized pumice stone, 12 ounces lampblack, 6 ounces pulverized rotten stone, 16 ounces shellac, and 1 gallon alcohol. Mix the first three in enough alcohol to make a thick paste, and dissolve the shellac in the rest of the alcohol. Mix all together. It may be put on brown paper (such as surveyors use), as well as on walls or boards.

Or, dissolve 2 ounces of gum shellac in 1 pint of alcohol, and after it is well dissolved, which will take about two days, add 1 ounce of lampblack and 2 ounces of powdered rotten stone or powdered emery. Apply with a flat brush.

Slat Iron. The iron shoe or termination of the bow or slat of a carriage top. The shoe is hinged to the stem by a pivot-pin and has an envelope of leather. The illustration represents a three bow pattern made with a sleeve running through the slats to give them free action, and prevent their binding on the nut and turning it off.

Fig. 2180.



Slat Iron.

Sleep'er. *Iron Cross-tie.* This tie is semi-elliptical in shape, resting simply on the ballast. The rail is fastened to the cross-tie by a jaw bone chair that is formed in two portions that hook into one another and hold the rail as in a vise. Half of the chair is fastened to the cross-tie by a bolt preferably on the outside of the track while the other half hooks into the first beneath the cross-tie and is immovable. An ordinary eye-headed bolt entering through the hole of the tie adapts itself to the end of this movable arm, and by its successive tightening compensates for any downward wear of the rail.

Iron, *Rock* . . . . . * "*Min. & Sc. Press*," xxxvii. 393.
Railway (of glass).
Siemens . . . . . * "*Scientific American*," xli. 201.
Preserving . . . . . "*Engineering*," xxx. 15.
Iron Railway, *Hilf*, Ger. * "*Engineer*," xlviii. 359.
Macdonnell, Br. . . * "*Engineer*," xlviii. 427.
Hohenegger, Ger. . * "*Engineer*," xlviii. 427.
Hensinger von Waldegg, Ger. . . . . * "*Engineer*," xlviii. 427.
Scheffler, Br. . . . * "*Engineer*," xlviii. 302.
Livesey, Br. . . . . * "*Engineer*," xlviii. 195, 315.
Maclellan, Br. . . . * "*Engineer*," xlviii. 265.
Vantherin, Ger. . . * "*Engineer*," xlix. 115.
Potel, Belgium . . . * "*Engineer*," xlix. 241.
Brunon, Fr. . . . . * "*Engineer*," xlix. 241.
Acaster, Br. . . . . * "*Engineer*," xlix. 304.
And permanent way iron.
Kirsch, Belgium . . * "*Engineer*," xlviii. 445.
Wm. Kler, Ger. . . * "*Engineer*," xlviii. 445.
Sleeping car, *Leighton* . "*Railroad Gazette*," xxi. 181.
Kellogg . . . . . * "*Scientific American*," xxxvii. 23.
Sleeping car berth, *Hills* * "*Scientific American*," xli. 307.
British . . . . . "*Iron Age*," xxi., Feb. 21, p. 5.

Sleeve. A short, relatively larger, pipe which receives the ends of two smaller ones and forms a coupling therefor. It may have *bell* or *flanged* ends. See, also, HUB, which has a similar purpose but somewhat different shape.

Sleeve Nut. A double nut with right and left hand threads for attaching the joint ends of rods or tubes.

Fig. 2281.

Sleeve Nut.

Slick'er. (*Leather.*) *Steel.* A rectangular piece of steel about 5″ long. The edge is also a rectangle, and is sharpened upon the rub-stone by grinding it perpendicularly, and then upon each side, producing thus two edges (or rather right angles) by which the leather is scraped instead of being cut. It is used to remove excess of water, oil, etc., from leather. Its applications are various. It has a handle like that of a stock-stone.

Glass or Lignum-vitæ. These are similar in form and dimensions to the steel slicker, but the blades are made either of thick plate-glass or lignum-vitæ. The edges are rounded instead of being rectangular. They are chiefly used to smooth out and polish leather.

Buffing. This slicker has a narrower, longer, and very much thinner blade than the others. Its edge has an acute angular longitudinal groove running along it, thus forming two very keen cutting edges, which are kept in proper condition by the finger-steel. It is used by placing one edge and the stock flat upon the leather, the latter being stretched upon the table, and forcibly pushing it forward, taking off thin shavings from the grain surface. When one edge is dulled the slicker is turned over and the other side used until it loses its edge, when the finger-steel must again be brought into requisition.

Whitening. This instrument has almost the same form and dimensions as the buffing slicker, but instead of a reëntrant angle along the edge, it has a very narrow rectangular one, whose angles are kept sharp by the finger-steel.

Slick'er-sides. (*Mining.*) Smooth, polished surfaces of walls caused by violent trituration.

Slick'ing. (*Leather.*) An operation consisting in scraping the leather, to remove superfluous water or grease, and eradicate the marks left by the stock-stone.

Slide. (*Lumbering.*) A chute for logs over rapids or shoals where such obstructions to floating logs exist in rivers. The slides of the Ottawa river extend at intervals for 200 miles above the city of Ottawa.

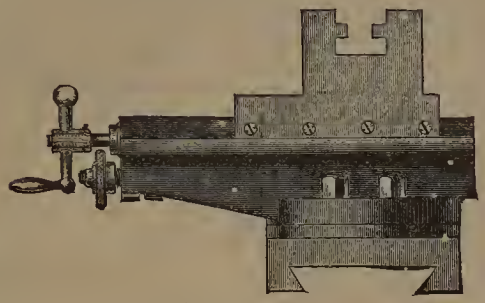
On the river Saguenay there is a slide 5,840′ long, with a boom 1,314′; and dams, piers, and bulkhead. The works extend over a distance of about six miles. Slides are constructed on the rivers St. Maurice, Gatineau, Madawaska, Petawawa, and Du Moine. On the rivers mentioned the

works are said to comprise: Slides, 12,835′; booms, 67,799′; dams, 17,791′; bulkheads, 346′; bridges, 2,215′; piers, 141.

Slide Cut′-off. (*Steam.*) An independent sliding plate riding on the back of the main valve, of which Meyer's system of valve-gear is a familiar instance.

Slide Rest. This rest has an ordinary cross-feed screw, but by a movement of the clutch, the

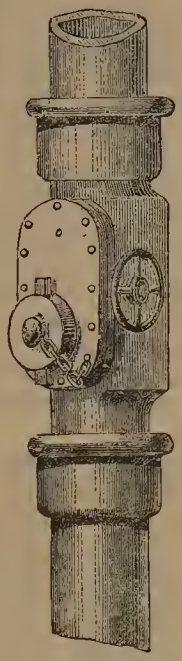
Fig. 2282.



Universal Slide Rest.

screw becomes neutral and transfers its feed through beveled gears, to a screw working at an angle to the first, the upper slide being swiveled, for adjusting to the desired angle, by means of a degree scale.

Fig. 2283.



Slide Valve.

The upper screw is also controlled by a friction feed enabling the tool to be quickly adjusted by hand without disengaging the clutch on the cross-feed screw, See Fig. 2282.

Shaws Co., Engl.
"*Scientific American Sup.*," 583.
Slide rest lathe.
* "*Scientific American*," xl. 404.

Slide Valve. This sliding valve is constructed so as to form part of the conducting pipe, instead of projecting from it as usual, so that the outlet to which the hose is attached can be kept close to the wall.

The sliding valve is worked by a rack and pinion arrangement; the front or cover plate is of gun metal, with the outlet screwed to receive hose, and fitted with gun metal cap and chain, also hand-wheel or spanner or spindle for opening and closing the valve.

* "*Sc. American Sup.*," 803, * 1527.
Allen.
* "*Railroad Gazette*," xxiv. 101.
Ancona.
* "*Railroad Gazette*," viii. 295.
Church, Br.
* "*Engineer*," xlii. 281.
Everitt, Br. . . . . * "*Engineering*," xxx. 27.
Wilson . . . . . * "*Railroad Gazette*," viii. 33.
Aveling & Porter, Br. * "*Engineer*," xlviii. 430.
Balanced, *Wisner* . . . * "*Scientific American*," xxiv. 374.
Taylor-Weatherhogg . * "*Scientific American Sup.*," 319.
Weatherhogg . . . * "*Engineering*," xxi. 168.
Circular, *Webb* . . . . * "*Engineer*," xliv. 69.
Diagrams, appa. for drew. * "*Engineering*," xxi. 388.
Expansion riding valve.
Crohn, Br. . . . . * "*Engineering*," xxv. 151.
Indicator, *Cooper*, Br. . * "*Engineering*," xxii. 393.
Locomotive, *Volga & Don Ry.* . . . . . * "*Engineer*," xlix. 376.
Oller . . . . . * "*Railroad Gazette*," xxiii. 533.
Setting apparatus . . * "*Engineer*," xlvi. 377.
* "*Scientific American Sup.*," 193.
Seat, *Walkey* . . . . * "*Railroad Gazette*," xxiv. 390.
Friction of, *Rose* . . . * "*Scientific American*," xxxvi. 264.
Shifting for winding engines . . . . . * "*Engineering*," xxv. 276.

Sli′ding Door. One running on hangers, sheaves, rollers, or rail; as distinguished from one swinging on hinges.

Sli′ding-door Lock. A lock made especially for fastening sliding doors of cars, for instance. Such locks usually have a hook which engages in a corresponding catch attached to the door-post. The hook may be locked by a bolt operatable by a key.

Slings. (*Boat.*) Ropes with hooks and thimbles whereby to hook the tackles to the ring bolts of the boat in lowering or hoisting.

(*A hoisting device.*) A pair of hooks for clasping a can or cask to be lifted.

Sling Wag′on. A military wagon for carrying a cannon slung beneath the hind axle, which has a large pair of wheels. Plate XLVI., "*Ordnance Report*," 1877.

Russian gun sling, Fig. 27, Appendix L, same report.

Slip Shave. A point or shave made to slip over the nose of the mold-board.

Slip Stop′per. (*Nautical.*) A cable stopper so arranged as to be cast loose suddenly when required.

Slit′-bar Sight. (*Rifle.*) A form of sight having a plate with a vertical slit. See BAR AND SLIT-SIGHT.

Slit′ting Mill. An English term for a gang of thin saws, used in ripping pine balks, known as *deals*, into thin boards. A resawing operation. See RESAWING.

Slit′ting Shear. A machine for slitting sheet metal.

In Bliss's machines, Nos. 104 and 106 of the 1881 catalogue, sheet metal up to 18 gage (Browne & Sharpe) is received in a roll, fed automatically, and the scrap coiled.

Sliv′er-ing Knife. (*Fishing.*) For slicing the flesh from the sides of fish, to be used as bait.

Sliv′er Lap Ma-chine′. A machine designed to unite in one broad sheet or lap a number of slivers or ends of cotton from the carding engine.

The sliver, when stripped from the doffer of the carding engine, passes to a coiler, by which it is deposited with mechanical regularity into a can. A certain number of these cans are placed behind the sliver lap machine, and the sliver is drawn from them through guides to a pair of fluted rollers which press the fibers, and form them into a fleece. They are then wound on a bobbin revolving between two iron revolving plates The slivers are made to pass over a number of spoons, so arranged that if any of the slivers break the machine immediately stops. When cotton with short staple is used, two calender rollers are placed on each side of the table to assist the sliver in its passage from the can to the guide plate.

Slot Bor′er. A tool used for opening the cut in connection with slotting machines.

Slot-bor′ing Ma-chine′. A machine intended to supersede reciprocating mortising machines in which the wood had first to be bored so as to give clearance for the chisel; this machine combining the two operations in one.

In these machines the workman presses the borer in with his right hand, and moves the wood with the other. The horizontal machines are especially adapted to usual mortising. See ROTARY MORTISING MACHINE, *supra*.

Slot Dril′ling Ma-chine′. Whitworth's self-acting slot-drilling machine has a sliding head-stock carrying the crank motion. The drill-spindle revolves in conical steel bearings. It has a horizontal slide-bed and two tables adjustable vertically and longitudinally.

Double, self-acting.
Daglish, Br. . . . . * "*Engineering*," xxx. 298.
Slotting machine.
Asquith, Br. . . . . * "*Engineering*," xxvii. 257.
Collier, Br. . . . . * "*Engineer*," xliii. 254.
Collier & Co. . . . * "*Scientific Amer.*," xxxviii. 242.
English . . . . . * "*Scientific American*," xxxiv.

Reversible tool atta. for
Garvie, Br. . . . * "*Engineering*," Oct. 15, 1880.
Sellers . . . . . * *Thurston's* "*Vienna Exp. Rept.*," ii. 218.
Sharpe, Stewart & Co., Br. . . . . * "*Engineering*," xxv. 488.

Slub'bing Frame. A machine used in the process of cottou spinning next to the draw-frame, to reduce the thickness of the sliver and impart to it a little twist previous to its passage through the intermediate frame, the roving frame (and where line counts are spun, the jack frame) which delivers it to the mule.

The slubbing frame exhibited by Dodson and Barlow, at Philadelphia, had 36 spindles, 10″ lift, 8″ space, three lines of rollers, and single boss top rollers.

It was claimed to possess the following advantages: —

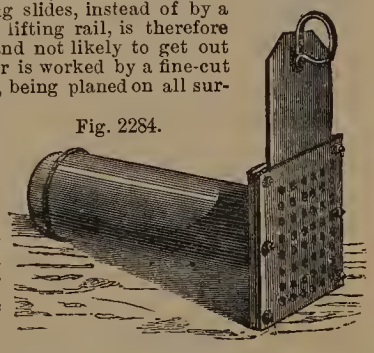
1. The differential motion is completely boxed up, so that no dirt or fly can get among the wheels; there is only one place for lubricating this motion, and the oil cannot work itself out but travels to each bearing which requires lubricating.

2. The swing lever which carries the carrier wheel that drives the bottom shaft, is firmly hung from the beam and has no vibration at whatever speed the spindles may revolve. In the swing there are also loose brackets or slides, which work on a plaued surfacc, and when the wheel becomes so far worn as to be slack in gear with the bottom-shaft wheel, these slidcs can be loosened, and the wheels can be nicely adjusted by a few turns of a screw.

3. When the frame is doffing, the bottom cone drum is worked up by a screw either from back or front. Both ends of the bottom cone rising simultaneously, it is impossible for the cones to become unparallel.

4. The tapering motion, which is carried on a rail attached to two of the lifting slides, instead of by a bracket fixed to the lifting rail, is therefore much more rigid and not likely to get out of order. The taper is worked by a fine-cut square rack, which, being planed on all surfaces, causes the rack to work very smoothly and consequently a regular taper on the bobbins is obtained.

Fig. 2284.



Sluice.

Sluice. A water way with valve or gate for controlling the flow of water. See "*Mech. Dict.*," p. 2217.

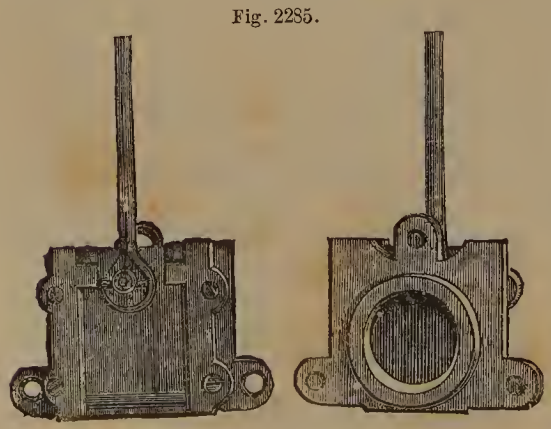
A water way with trap, stop-valve, or screen for the arrest of obstructive substances.

For silver tailings, Nev. * "*Engineering*," xxx. 395, 451.
Ore, *Evans* . . . . . "*Min. & Sc. Press*," xxxvii. 406.
Valve, Equilibrium.
Bagshaw, Br. . . . * "*Engineer*," xliv. 148.

Sluice Fork. A many tined fork for clearing obstructive substances out of sluice ways and water courses.

Slui'ces. (*Mining.*) Boxes joined together, set with riffle blocks, through which is washed auriferous earth.

Fig. 2285.



Sluice Valves.

Sluice Valve. A sliding valve made so as to be secured to the bulk-head by three bolts instead of by screwed shank and fly-nut. For vessels built in compartments, with gun-metal frame and valve. It passes upward through a brass hinged flap on deck above, so as to open valve without going below. Fig. 2285.

Smash'ing Press. An embossing press.

Smee Bat'ter-y. (*Electricity.*) A single fluid battery having a sheet of roughened platinum between two plates of zinc in sulphuric acid. See "*Mech. Dict.*," p. 2220.

Prescott's "*Electricity*," * 74; Ganot, * 689.
De Moncel, Paris, 1856, 107.
Noad, London, 1859, * 274.
Shaffner, N. Y., 1859, * 93.
Niaudet, American translation, * 54.
Poggendorf's improvement, *Niaudet*, 59.

Smelt'ing Fur'nace. A furnace for reducing ores. See "*Mech. Dict.*," p. 2220, *et seq.*

Boston & Col. Smelting Works . . . . . * "*Engineering*," xxii. 247, 317.
Kony, India . . . . * "*Scientific American*," xxvi. 151.

Smoke'-burn-ing Fur'nace. M. Ten-Brink's smoke-burning furnace has the heater placed below with its major axis at right angles and horizontal to that of the boiler. One or two furnaces traverse the heater, making with the horizon an angle of 48°. In these furnaces is placed the grate, formed of a table and bars, the latter resting on the table at one extremity and at the other on a support at the end of the furnace. The table has two lateral sides surmounted by a cover so that a close four sided box is formed upon the door and grate extremities. The front piece to which this box is attached is a plate of cast-iron in which several different openings are made. A flue regulated by a hinged cover above the entrance to the furnace admits air in order to insure the complete combustion of disengaged gases.

See also "*Scientific American Sup.*," 962.

Smoke burning furnace. * "*Scientific Amer.*," xxxvii. 282.
Dumery . . . . . * *Laboulaye's* "*Dict.*," iv., "*Fumée*," Fig. 3538.
Smoke preventive . . * "*Scientific American Sup.*," 962.
Smoke burning furnaces,
On, *Hill* . . . . . "*Van Nostrand's Mag.*," xxii. 62.
Smoke-burning furnace. "*Eng. & Min. Jour.*," xxvi. 422.
Clark . . . . . "*Iron Age*," xxii., Nov. 21, p. 20.
Smoke burning grate.
Jordan . . . . . * "*Scientific American*," xxiv. 403.
Smoke consumer . . . "*Scientific American*," xxxv. 18.
Smoke-consuming furnace "*Scientific American*," xxxix. 138.
Hoyt . . . . . * "*Scientific American Sup.*," 1120.

Smoke Con-su'mer. The methods proposed for consuming smoke are very numerous.

Papin proposed the downward draft, making the smoke descend through the fire, as in Delasme's base burner, 1685 (Fig. 5911, p. 2410, "*Mech. Dict.*"). In Papin's the draft was obtained by means of a blower; the idea has never fructified into useful form.

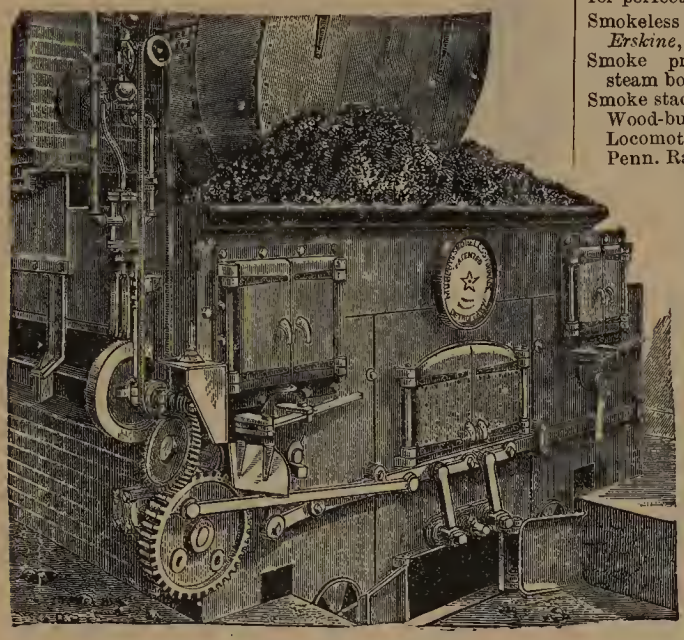
Watt had a wide dead-plate between the furnace doors and grate bars; on this the coal was coked before being pushed back and burnt. This plan is excellent, but requires careful attention. The smoke and gases evolved in combustion of the fresh coal are consumed while passing over the incandescent mass of fuel at the back of the furnace.

A given quantity of air has been introduced above the fire-bars, to insure the combustion of the smoke; this is good in theory, but the regulation is difficult in practice, as, when coal is freshly introduced, a larger quantity of air is required than at other times.

Henderson's mechanical stoker has hoppers above the furnace doors, and the coal is gradually dropped into the furnaces by automatic devices driven by the engine. See STOKER.

Prideaux's has fire doors, in which the air enters through a number of Venetian lattices, and is warmed by contact with metallic plates before reaching the furnace.

Fig. 2286.



Murphy's Smokeless Furnace.

Richardson, C. J. "*The Smoke Nuisance, and Its Remedy by Means of Water.*" With Remarks on Liquid Fuel. London, 1869.

Smoke Con-sump'tion. A new device in smoke consumption on trial in Chicago has special adaptability to all kinds of boilers.

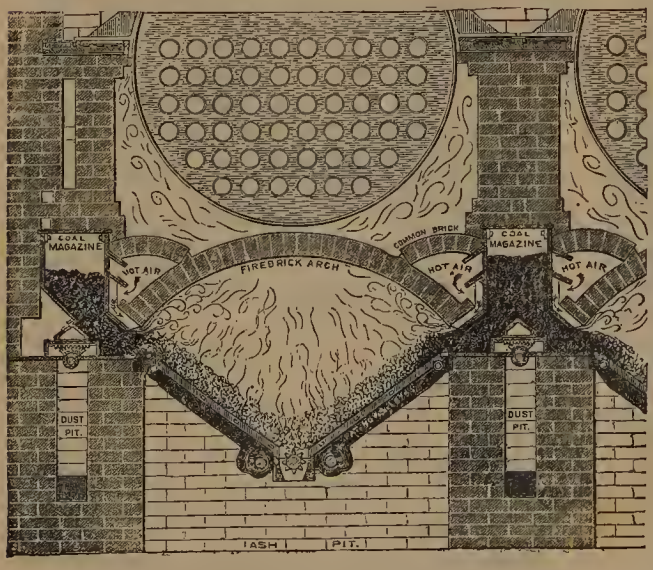
A jet of steam is introduced, creating a vacuum into which the outer air rushes, and the commiugled steam and air are delivered into the fire chamber. In this the proportions are one part steam to two hundred parts of atmospheric air.

This creates an intense draft, and, it is claimed, the entire consumption of the carbon contained in the soot.

Smoke'less Fur'nace. Murphy's smokeless furnace (see Figs. 2286, 2287) obtains its complete combustion by a natural draft, being fed automatically, and having a steady, uniform feed and therefore an even temperature.

The fuel is put into magazines and pushed very slowly on plates, cooking it before it enters upon the grates. A current of air by natural draft passes over the heated arch above and down at the sides, supplying the mixture of air necessary for perfect combustion.

Fig. 2287.



Murphy's Smokeless Furnace.

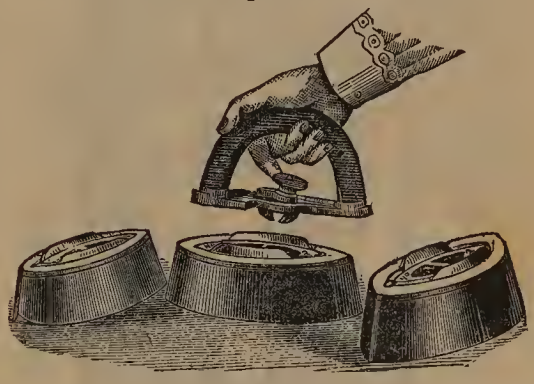
Smokeless furnace, *Regan* * "*Scientific American Sup.*," 1363.
Erskine, Br. . . . . * "*Engineer*," xlvii. 79.
Smoke preventer for steam boilers . . . * "*Scientific American Sup.*," 524.
Smoke stack, *Hewitt* . * "*Railroad Gazette*," xxiii. 459.
Wood-burning, *Finley* * "*Railroad Gazette*," xxiv. 281.
Locomotive, *Turner* . * "*Scientific American*," xl. 86.
Penn. Railway . . . * "*Engineering*," xxiv. 123.

Smooth'ing I'ron. Pott's Cold Handle Double-pointed Smoothing Iron has a semi-circular handle that is made of a non-conducting material, so as not to convey the heat from the iron below, and is attachable to the iron by a spring catch that holds it in position while in use, and is readily detached through the pressure by the finger of the knob above when it is desired to transfer it to another iron. See Fig. 2288.

Enterprise Co. * "*Iron Age*," xix., Jan. 4, p. 1.
Sad iron, *Hasenritter* . . . * "*Iron Age*," xvii., Jan. 26, p. 5.
Sad iron and fluting roller. *Kramer* . . * "*Scientific American*," xli. 102.

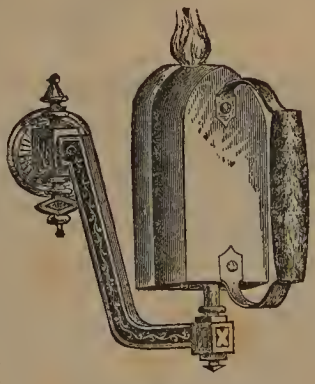
The gas-heating toilet smoothing iron (see Fig. 2289), it is said, can be heated in three minutes on any ordinary gas burner. They are especially adapted for gentlemen to iron their silk hats, and for ladies while traveling; also for dress-making and other general uses.

Fig. 2288.



Smoothing Iron.

Fig. 2289.

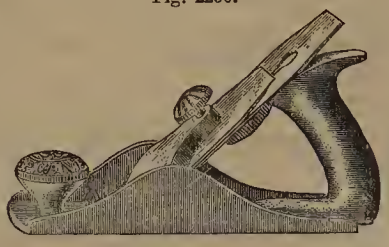


Gas-heating Smoothing Iron.

Smooth Plane. One the bit of which is set at a relatively more obtuse angle than that of a *block* plane. The former is for planing with the grain; the latter across it. See Fig. 2290. See BLOCK PLANE. See also SCRAPER PLANE.

Smut Ma-chine'. A machine for cleaning from wheat the smut, and also dirt and the beard, the latter on the end opposite to the germ. By a certain vigor in the process the bran is also partially removed. The wheat is passed between sharply roughened or pointed iron

Fig. 2290.



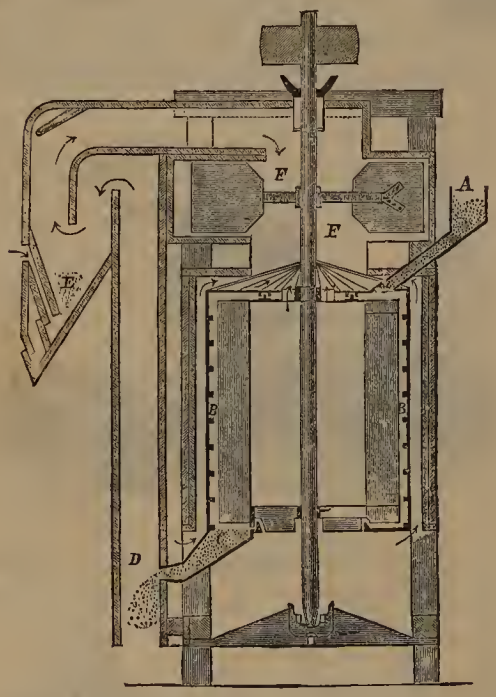
"*Victor*" *Smooth Plane.*

surfaces, as teeth or wire brush, or beaten upon the surface of a cylinder or conical frustum, revolving at high speed within a metallic case perforated with holes or slits, serving the double purpose of permitting the dust to escape and presenting a rough surface.

Howes, Babcock & Co.'s machine for removing smut, pointing, and cleaning grain is shown in Fig. 2291.

The wheat enters at *A*, passes through the cylinder *B B*, comes through *C* to *D*, where it encounters the current of air produced by the exhaust-fan, which conducts the light

Fig. 2291.



Wheat Grading and Purifying Machine.

kernals to *E*, the bran to *F*, and the fan-chamber which leads to the dust and bran chamber. The air moves in the direction indicated by the arrows. The particles of dust, hairs, smut, etc., that pass through the walls of the cylinder *B B*, are carried by the exhaust to *F*. The excellence of the work of this machine is indorsed by Professor Kick in his official report to the Austrian government.

The Eureka smut and separating machine has a separator attachment above the shoe in such manner provided that the dust from the entire machine is all absorbed by the fan.

The capacity of No. 2 is 40 to 60 bushels per hour, and like the Nos. 0 and 1 has two separators, one before and one after the scourer. Motion, 625 revolutions per minute. Standard size, pulley 10″ with 5½″ face.

Snap Ac'tion. (*Fire-arm.*) As distinguished from a lever gun; one which as the hinged barrel closes is fastened by a spring catch.

Snap Block. (*Nautical.*) A block with an opening in the side at which the rope may be laid in the sheave without the trouble of reeving it in. See Fig. 2292.

Snap Ma-chine'. A machine for cutting a

Fig. 2292.

Snap Block.

blanket of dough into snaps. A kind of biscuit; ginger snaps for instance. See CRACKER MACHINE.

Snarl'ing. A mode of producing repoussé work upon any hollow ware of sheet gold, silver, etc., by blows delivered inside. The snarling tool is placed in a vise and the protruding end enters the object and rests against the inside. A blow delivered on the shank of the snarling iron is transferred to the object, and makes a dent which appears as a bulge on the exterior. See SNARLING IRON, p. 2229, "*Mech. Dict.*"

Snatch'ing Rol'lers. (*Printing Machine.*) A pair of rollers driven at a somewhat higher speed than the pair of holding rollers next in the rear of them, in order to *snatch* or break the paper on the lines of the perforations and thus make them into separate sheets.

Sneak Box. The New Jersey sneak box is from 12′ to 14′ in length; the shelving or sideboards on the stern of the boat are used to hold the decoys while the hunter rows to and from the shooting ground. Used by gunners on Barnegat and Little Egg Harbor Bays, New Jersey. The Maryland ducking-sink is used by gunners on the Potomac River and Chesapeake Bay.

Snood. (*Fishing.*) The short line which carries the hook and is attached to the fishing line. A *snell*, *leader*, or *trace*.

Made of catgut, silk, gimp, wire, flax, silk-worm gut, etc.

Snow Flan'ges. (*Railway.*) A bar of iron or steel attached to a car or engine to scrape away snow and ice on the sides of the heads of the rails so as to make room for the flanges of the wheels.

See "*Scientific American*," xl. 372.

Snow Plow. A plow-shaped apparatus mounted on wheels and propelled by locomotives, used in cutting a way through snow drifts.

Those used in the vast drifts on the Pacific railroad are 13′ high, 10′ wide, and 30′ long. They are mounted on two trucks and weigh 38,000 pounds each. The body of the plow is made of the best lumber, the furrow board of polished ash, running back at an angle of 31° and up, in a half circle of 19″ radius. The apron is of ⅜″ boiler iron and has steel shoes, clamped on the rail by clamps 3′ long. The drifts sometimes become so compacted that they resist the butting action of the plow for a long time, and as high as fifteen locomotives have united their combined power before they could push the plow through the drifts.

Snow plow, *Little* . . * "*Scientific American*," xxxvi. 226.
Snow plows, railway . * "*Scientific American Sup.*," 731.

Snow Scra'per. 1. (*Railway.*) A plate or bar of iron attached to an engine or car to scrape snow and ice from the rail.

2. An A-shaped plow made of two scantlings and a cross-piece, for cleaning snow off sidewalks. The driver stands on the cross-piece; the horse is hitched to the point of the A.

Snug'ger. A device to impart a smooth and dense exterior and uniform thickness to twine.

Soap. In the preparation of toilet or perfumed soaps, the blocks of rough soap are first cut into thin shavings in a planing machine, and the shavings are then ground with coloring matter, essential oils, and scents, until they form a homogenous paste. The machine for grinding contains granite cylinders, which pass the paste automatically between them, and finally into the upper portion of the hopper, so that the services of only one attendant are required for several machines. After the paste has been ground, it passes to a machine called the *peloteuse,* or mixing mill, which stretches and draws it out and prepares it for being molded and stamped. The *peloteuse* does instantly what at one time required several weeks of scraping, washing, and drying. It is a mortar, in which the soap paste is packed until it is freed of air, and from which it is then forced by increase of pressure, passing through draw plates of any required cross section.

A self-acting cutter divides the stream of soap into blocks of any desired size or weight.

Phosphate of soda is being used in a composition with the common soaps, as especially adapted for use in salt water, as well as fresh water.

(*Glass.*) Binoxide of manganese used to correct the greenish tinge in glass, due to the presence of iron in the sand. Glass made with potash is freer from this coloration but is expensive, hard, and difficult to work.

Binoxide of manganese in excess turns the glass to rose color, purple, and even black, according to the quantity used. It is used in small quantities as a corrective. In the French practice the proportion is 0.5 per cent.

Soap machinery, toilet . * "*Man. & Builder,*" ix. 16, 40.
Soap making machinery * "*Scientific American Sup.,*" 4107.
Slicing . . . . . * "*Engineer,*" 1. 280.
Grinding . . . . . * "*Engineer,*" 1. 280.
Kneading . . . . . * "*Engineer,*" 1. 280.
Stamping . . . . . * "*Engineer,*" 1. 280.
Soap works, *Babbit* . . * "*Scientific American,*" xli. 335.

Soap Cut'ter. An apparatus for caking or barring soap in manufacture. See Soap Barring and Cutting Machine, p. 2232, "*Mech. Dict.,*" and Soap Cutting Machine, p. 2233, *Ibid.*

Soap Coil. One fitting the interior of a soap boiling kettle, and through which the steam circulates to boil the ingredients.

Sock'et. A tool used in well boring to recover and lift rods out of the well. They are of different shapes, screwing on to the top of the rod, attaching by gripers, hooks, shoulders, collars, spreaders, etc.

Sock'et Gud'geon. One in which the gudgeon shoulder surrounds the wooden shaft, instead of being let into the shaft. In the illustration (Fig. 2293) it is shown as attached to a conveyor or bolt-reel shaft.

Fig. 2293.

Socket Gudgeon.

Sock'et Pipe. One having an enlarged end to receive the end of another pipe, and contain the lead or other cementing material used in joining the pipes.

Fig. 2294.

Socket Washer.

Sock'et Wash'er. A washer having a counter-sunk face into which the head of the bolt sinks. See Fig. 2294.

So'da Ap'pa-ra'tus. Soda is manufactured principally, now, from common salt.

The manufacture of soda from kelp is comparatively unimportant.

The manufacture from the cryolite of Greenland, is limited practically to that country. Extensive deposits of natural soda, enough to supply the world's demands for centuries, are said to have been discovered in Wyoming territory. Large amounts of the sulphate of sodium are obtained in France and Germany from the mother liquors remaining after the extraction of chloride of potassium.

Jones & Walsh's furnace consists of a large shallow pan, exposed to a free coke fire in which the entire reaction takes place. An axle above the pan having a series of propelling iron shovels agitates the salt. About four fifths of the necessary amount of sulphuric acid is admitted by leaden pipes, and the machinery is set in motion. The evolution of hydrochloric acid is very regular. At the end of fifteen minutes a small quantity is taken out for test, and the rest of the sulphuric acid added.

Camack and Walker admit the chloride of sodium and sulphuric acid at one end of a long horizontal cylindrical rotating furnace, which issues at the outer end in the form of soda.

Hargreaves and Robinson attempt to shorten the process, and effect the formate of sulphate by bringing the gases from the pyrites burners, directly into contact with chloride of sodium at the proper temperature. The finely powdered salt is pressed into small cakes about 1½″ inches thick, and placed in a series of from 8 to 14 cylinders, 15′ in diameter and 12′ high, so united that gas entering at one end of the series must pass through all. The cylinders are kept at a dull red heat for fourteen to twenty days. The current of sulphurous anhydride, air, and superheated steam entering the cylinder in which the reaction is nearest completion, passes on through cylinders containing less and less of sulphate until the mixture of gases and vapor is deprived of all or nearly all sulphurous anhydride when it reaches the last cylinder containing salt scarcely attacked, and issues thence laden with hydrochloric acid to the condensing towers. As the action in one cylinder is completed, it is switched off and emptied and the next is advanced to its place.

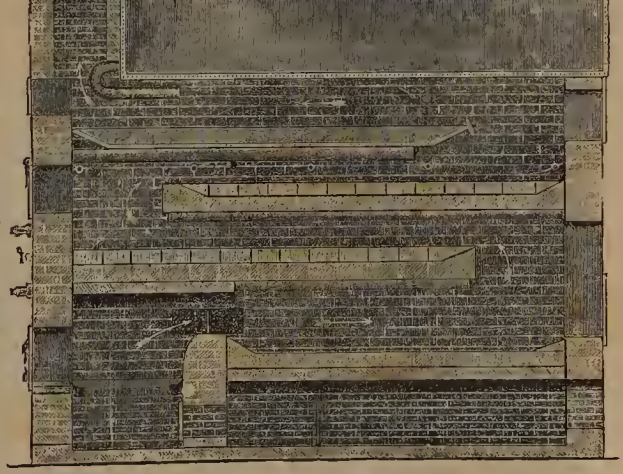
See Prof. Jenkins' report on chemical industries, "*Paris Exposition* (1878) *Reports,*" vol. iv., page 32, *et seq.* And Kuhlmann's report on The Chemical Acts, Group III., vol. iv., "*Centennial Exhibition Reports,*" page 93.

Soda appa., * Lixiviating.
Shank . . . . . * "*Scientific American,*" xlii. 67.
* Revolving furnace * "*Scientific American,*" xlii. 67.
Soda carbonate apparatus
McCloskey . . . . * "*Scientific Amer.,*" xxxvi. 226.
Soda processes, Fr. . . "*Scientific American Sup.,*" 2325.
Soda process, *Solvays* . "*Scientific Amer.,*" xxxiv. 403.

So'da Ash Re-claim'er.

Fig. 2295 shows an ash furnace for reclaiming soda-ash liquor after it has been employed to reduce wood to a pulp. The liquor is first placed in a tank of iron over the top of the furnace, and is generally from 7° to 15° in strength. From the tank it descends first into an iron tray that has a slight slant to allow the liquor to gradually drop on to the next pan or tray. The second tray is made of fire-brick plates, 42″ wide; the third tray is made the same way. The liquor is gradually pushed down over these trays until the incinerating hearth is reached. To reclaim liquid soda ash into black ash requires a long flame and high heat, as not only must the water be evaporated out of the liquor, but

Fig. 2295.



Soda Ash Reclaimer.

the particles of wood must be burned. This requires soft or bituminous coal, waste wood or saw-dust; by discharging hot air on top of the fire the gas is ignited, and the flame is extended to the top pan or tray.

So'da-wa'ter Ap'pa-ra'tus. The principle of making aërated waters by the American system is by charging a cylinder of water with carbon gas, under pressure evolved by the mixing of sulphuric acid and whiting or marble dust. As used in England and her colonies, and on the Continent, the gas is made in a leaden generator, and by its own force issues into a gasometer, where it remains until it is pumped, with the water to be bottled, into the condenser, and is here mixed together by an agitator.

One of the first attempts to make artificial waters was made by Thurniessen in 1560, and from then to the present time the machinery for the manufacture has gradually been perfected. The system at present in use in the United Kingdom and on the Continent, is identical. It is what is called the "continuous direct action process." The principle of this is as follows: The carbonic acid gas is made in a leaden vessel, the carbonate being placed in, generally mixed with water, the acid, which is contained in a continuous vessel, being poured on by a simple arrangement in just sufficient quantities to generate the gas, no more being used than is absolutely required for the purpose, the waste product when exhausted being easily drawn off and a fresh charge inserted.

Various materials are employed as carbonates, these varying, of course, with circumstances, depending entirely on their handiness and cost; whiting, marble dust, carbonates of soda and magnesia, and very many other substances being used. The marble is supposed to effervesce less violently than less compact forms of carbonate of lime.

See "*Mech. Dict.*," pp. 2236, 2237.

So'da-wa'ter Foun'tain. Fig. 2296 shows a seamless fountain with glass reservoir inside a copper one, which withstands a pressure of 500 lbs. There is no pressure on the glass, as it is balanced by the gas between the two shells.

Fig. 2296

Seamless Soda-water Fountain.

So'da-wa'ter Foun'tain Cock. The coupling to which the pipe is attached passes into a square, hollow box, and by means of a thumb-screw is made tight; avoids all twisting and breaking of pipes, and requires no wrench.

Sod Plow. Avery's plow turns the sod either to right or left, and lays it so as to put ordinary grass out of sight.

So'fa Bed. A sofa whose seat is hinged to open out, the under side of the seat and the exposed part of the sofa, when unfolded, forming a mattrass.

Soft-board'ing. (*Leather.*) Boarding or bruising the leather on the flesh-side; it renders the skin very pliant.

Soft Cen'ter Steel. A composition of iron and steel. A mold is divided into two or more sections by sheet or plate iron partitions. The metals are poured into their respective chambers, and the partitions, fused by the heat, weld the mass together. Used for safes, plows, etc.

The character of the center, that is, whether it shall be "hard" or "soft," of steel or iron, depends largely upon the use to which it is to be put. Where the use demands hardness on the outside for protection against wearing or abrasion, and at the same time considerable toughness in the center, as in plows, the center is soft or of iron. For ease of welding and toughness with rigidity, hard center or steel center is used. — *Iron Age.*

Soft Paste. (*Ceramics.*) A name applied to the material of porcelain, which is semi-hard only. It is of fine clay, with proportions of silex and other substances. A name applied either to the Worcester paste of England or to the *vieux Sèvres*. See PORCELAIN.

Soil Branch. A sewer pipe, making lateral connection with the hopper of a water-closet.

Fig. 2297.

Soil Branches.

a. Single soil branch. *b.* Double soil branch.
c. Hospital soil branch.

Soil Pipe. A sewer pipe serving a water-closet.

Soil-pipe ventilator, *Boyle*, Br., * "*Engineering*," xxix. 127.

Soil Pul'ver-i-zer. An implement for triturating the earth in preparing for seeding.

See HARROW; DISK HARROW; CLOD CRUSHER; ROLLER, etc.

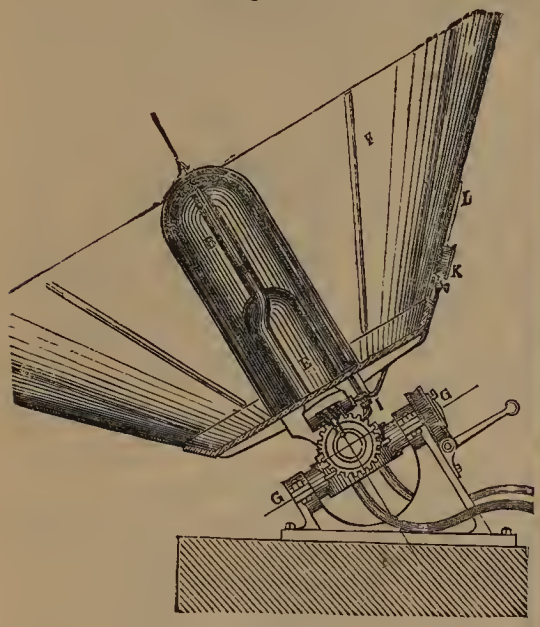
So'laire. An apparatus for using directly the heat of the sun's rays. The resolution of this difficult problem has been attempted from the time of Hero of Alexandria, B. C. 100, by Baptista Porta, Martini, Kircher, Bélidor, Oliver Evans, Ericsson.

The question is considered at some length in *Laboulaye's* "*Dictionnaire des Arts et Manufactures.*" tome iii., article "*Solaire,*" where Mouchot's apparatus is described and represented.

So'lar Boil'er. An apparatus intended to utilize the heat of the sun's rays.

Fig. 2298 shows Prof. Mouchot's solar boiler. *A* is a glass bell; *B* is a boiler with a double envelope; *D* is a steam-pipe; *E* is a feed-pipe; *F* is a conical silvered mirror; *G G* is a spindle around which a motion is given to the machine from east to west; *H* is the gearing regulating the inclination of the apparatus on the spindle *G G*, according to the seasons; *I* is a safety-valve; *K* is a pressure-gage, and *L* is a water-gage. The mirror has the form of a truncated cone, with parallel bases, and the generating line makes an angle of 45° with the axis of the cone. The incident rays striking parallel to the axis, are reflected normally to this axis, and give a heat area of maximum intensity for a given opening of mirror. The reflectors are formed of 12 silvered sectors, carried by an iron frame in the grooves of which they slide. The diameter of opening is 112.3″ at the top and 39.3″ at the bottom, giving an effective mirror area of about 45 square feet. The bottom of the mirror is formed of a cast-iron disk to add weight to the apparatus. In the center of this disk is placed the boiler, the height of which is equal to that of the mirror. It is of copper blackened on the outside, and is formed of two concentric bell-shaped envelopes connected at their base by a wrought-iron ring. The larger envelope is 31.5″ high, and the smaller, 19.68″; their respective diameters are 11.02″ and 8.66″. The water is introduced between these two envelopes, so that it forms a cylinder 1.18″ thick. The amount of water does not exceed 4.4 gallons, and about one third of the annular space is left as a steam-chamber. The inner envelope remains empty; it is furnished on one side with a copper pipe leading from the steam-chamber,

Fig. 2298.



Solar Boiler.

and connected with the motor by a flexible tube. At the foot of the boiler is placed the feed-water tube. The glass envelope or bell is 15.75″ in diameter, and 33.46″ high, the thickness of the glass being .2″ thick. A space of nearly 2″ is thus left between the sides of the glass and the copper envelope.

The apparatus is mounted on an inclined axis, the angle of which can be made to change to correspond with the motion of the sun, and a rotating movement of 15° per hour can also be given to it. To effect this double object, the apparatus is carried on trunnions resting on a shaft perpendicular to their axis, and this shaft forms, from north to south with the horizon, an angle corresponding to the latitude of the place. Two movements result from this arrangement which permit the apparatus to follow the course of the sun, since by a half revolution it turns from sunrise to sunset, whilst by an annual rotation of 46° at most on the trunnions, it is brought opposite the sun in all positions. This double movement is effected by means of worm gearing, the first being repeated at half-hour intervals, the second every eight days.

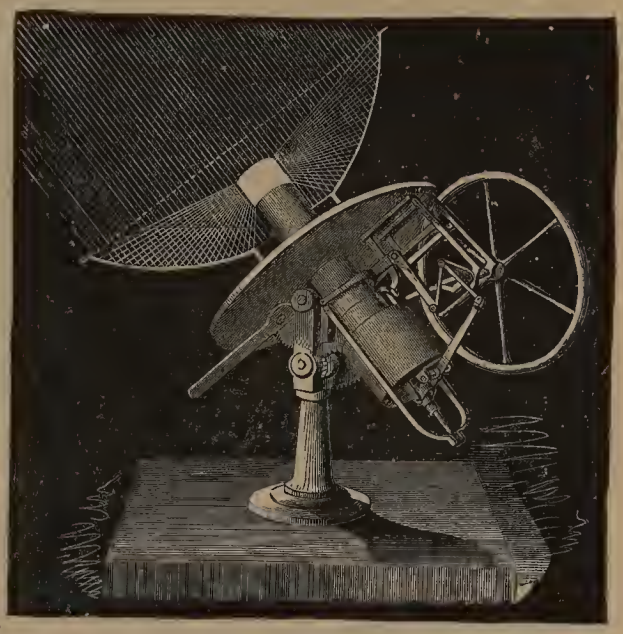
Experiments made with this apparatus at Tours showed that in 40 minutes 4½ lbs. of water were raised from a temperature of 68° to 252°, and thence to a pressure of 5 atmospheres. In less than 15 minutes, 33 lbs. of water of 212° were raised to 307°. Finally, in favorable weather, 11 lbs. of water have been evaporated per hour. The steam generated was employed for driving a pump.

The inventor of this apparatus points out various uses for which it may be employed, especially in warm climates, as, for example, for the distillation of water, either on shipboard or in rainless countries, for the manufacture of ice, in connection with the Carré apparatus for the distillation of alcohol, etc., and in the manufacture of sugar.

So'lar Ca-lor'ic En'gine. Fig. 2299 represents Captain Ericsson's new engine for the utilization of solar heat in the production of motive power. It is calculated that the heat radiated by the sun during nine hours per day, for all the latitudes comprised between the equator and the 45th parallel, corresponds per minute and per square foot of normal surface to the direction of the rays to 3.5 thermo units of 772 foot pounds. Hence, a surface of 100 square feet would give a power of 270,000 foot pounds, or from 8 to 9 horse-power. The engine illustrated is on the caloric system, and has run at 420 revolutions per minute with the sun near the zenith and during fine weather.

Solar caloric engine.
Ericsson . . . . . * "*Scientific American*," xli. 67.
Solar engine, *Ericsson* . * "*Scientific American Sup.*," 1104.
Mouchot . . . . . "*Eng. & Min. Jour.*," xxx. 26.
Solar heat, applications of.
Simonin . . . . . "*Iron Age*," xviii., Sept. 14, p. 7; Sept. 21, p. 5.

Fig. 2299.



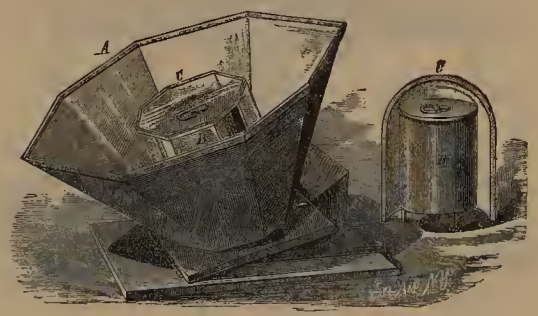
Solar Caloric Engine.

Appa., *Hittell & Dietzler* * "*Scientific Amer.*," xxxvii. 18.
Engine . . . . . * "*Man. & Builder*," xii. 254.
Sun engine, *Mouchot.* * "*Engineer*," xlvii. 39.
Paris . . . . . * "*Scientific American Sup.*," 2655.

So'lar Cook'ing Ap'pa-ra'tus. A device for utilizing the heat of the sun's rays for culinary purposes.

Fig. 2300 shows Adams's solar cooking apparatus used at Bombay. It consists of a conical reflector, *A*, made of wood and lined with common silvered sheet glass. Inside there is placed a copper cylindrical vessel, *B*, covered by a glass cover, *C*. The cooking vessel is raised about 4″ from the bottom, and the glass cover is 5″ longer than the vessel, and

Fig. 2300.



Solar Cooking Apparatus.

2″ wider, which leaves an interval of 4″ of hot air under the boiler and 1″ all round and at the top. The wedge under the apparatus is to keep it inclined, so that the rays of the sun may fall perpendicularly on the boiler. Glass being diathermanous to the direct or reflected rays of the sun, and non-diathermanous to obscure heat, the rays penetrate the glass, and, striking on the vessel, become transformed into obscure heat, when they are retained by the glass. The glass cover over the boiler is made octagonal, because, in that form common window glass can be used. The position of the apparatus requires to be changed about every half hour, to face the sun in its apparent course from east to west. The rations of seven soldiers, consisting of meat and vegetables, are thoroughly cooked by it in two hours, in January, the coldest month of the year in Bombay, and the men declare the food to be cooked much better than in the ordinary manner. Several people in Bombay and in the Deccan have tried it, and always with success. If the steam be retained the dish is a stew or a boil; if it be allowed to escape the food is baked. The reflector is 2/4″ in diameter. The intensity of the heat is increased by increasing the diameter of the reflector.

So'lar Lamp. 1. Another name for the argand lamp. It has a tubular wick and central duct that admit air to the interior of the flame. See ARGAND LAMP, p. 142, "*Mech. Dict.*"

2. One of the fourth class of electrical lights. In all electric candles the carbons are placed parallel to one another, and as the waste of the two must be equal, they are fed by alternate currents. Some of them have an automatic arrangement for lighting and relighting. The candles without columbin are to be referred to the voltaic-arc class; Jablochkoff's candles possess the characters both of the arc and of incandescence.

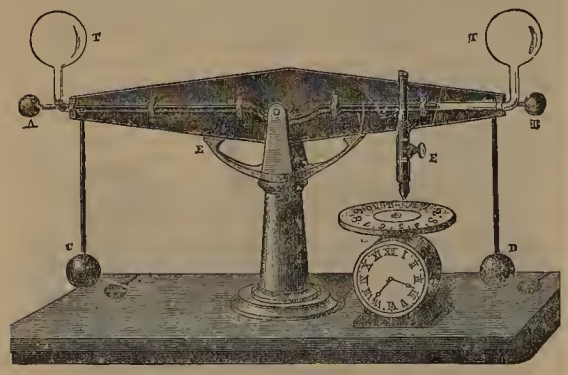
The Clere and Burean lamps are allied to the candle by the nearly parallel arrangement of their two carbons, and to the incandescence class by the nature of their light, produced as it is by a piece of chalk raised to a very high temperature, and made incandescent by the passage of the current across the voltaic are established between the two carbons, and which grazes its surface. In the case of the candles, as in that of the *lampe-soleil*, a certain number of apparatus can be placed in one circuit; hence we might regard them as a fourth class of electric light apparatus by division (polyphote regulators).

So'lar Pho-to-graph'ic In'stru-ment. An instrument for photographing the surface of the sun.

So'lar Ra-di-a'tion Reg'is-ter. An apparatus to automatically register the period the sun shines.

In Fig. 2301 the two bulbs of the thermometer *T T'* are covered with lampblack. The bulb *T* to the left is alone exposed to the open air, all the rest being inclosed in a box. When the sun shines the air contained in the bulb *T* dilates, and the mercury in the differential thermometer is driven into the tube, thus destroying the equilibrium of the balance. The beam then inclines, and the point of the pencil, which is fixed to the support *F*, rests on a paper circle fastened to a copper disk. This disk keeps constantly revolving on its axis, carrying with it a paper dial. When the sun is

Fig. 2301.



Solar Radiation Register.

no longer shining the balance resumes its equilibrium, the pencil ceases to touch the paper, and the tracings made by it are thus broken.

To complete the description of this ingenious apparatus we will add that the metallic balls *A B* are provided with screws, and serve to place the beam in equilibrium. The rods *C D* are made of metal, and are designed to prevent oscillation.

Sol'der. A fusible metal used to join two less fusible metallic bodies.

Jewelers will find the annexed list of silver solders of considerable practical value. Hard solder: Pure silver 16 parts, copper 3½ parts, spelter ½ part. Medium: Fine silver 15 parts, copper 4 parts, spelter 1 part. Easy solder: Fine silver 14 parts, copper 4½ parts, spelter 1½ parts. Common hard solder: Fine silver 12½ parts, copper 6 parts, spelter 1½ parts. Common easy solder: Fine silver 11½ parts, copper 6½ parts, spelter 2 parts. The fusing points of these solders are as follows: No. 1, 1,866° Fah.; No. 2, 1,843°; No. 3, 1,818°; No. 4, 1,826°; and No. 5, 1,802°.

See "*Mech. Dict.*," p. 2289.

A few solders, the metal to which they are applied, and their appropriate fluxes, are tabulated below.

Name.	Composition.
Soft, coarse	Tin, 1; lead, 2.
Fine	Tin, 2; lead, 1.
Fusible	Tin, 2; lead, 1; bis., 1.
Pewterer's	Tin, 3; lead, 4; bis., 2.
Spelter, soft	Copper, 1; zinc, 1.
Hard	Copper, 2; zinc, 1.
Silver, fine	Silver, 66.6; copper, 23.4; zinc. 10.
Common	Silver, 66.6; copper, 30.; zinc, 3.4.
For brass and iron	Silver, 1; brass, 1.
More fusible	Silver, 1; brass, 1; zinc, 1.
Gold, for 18 carat gold	Gold, 18 carats fine, 66.6; silver, 16.7; copper, 16.7.
More fusible	Same as above with a trace of zinc.
Platinum	Fine gold.

Material to be soldered.	Solder.	Flux.
Tin	Soft, coarse, or fine.	Rosin or zinc, chl.
Lead	Soft, coarse, or fine.	Rosin.
Brass, copper, iron, and zinc.	Soft, coarse, or fine.	Zinc, chl.
Pewter	Pewterer's or fusible.	Rosin or zinc, chl.
Brass	Spelter, soft.	Borax.
Copper and iron	Spelter, soft or hard.	Borax.
Brass, copper, iron, steel	Any silver, S.	Borax.
Gold	Gold, S.	Borax.
Platinum	Fine gold.	Borax.

To solder German silver, pour out some spirits of salt in an earthenware dish, and add a piece of zinc. Then scrape clean the edges to be soldered, and paint over with the spirit of salt. Apply a piece of pewter solder to the point and melt with the blow-pipe.

Comp. . . . . "*Iron Age*," xxi., March 21, p. 7.

Sol'der Cut'ter. (*Sheet-metal Working.*) A machine for chipping solder into pieces convenient for use in soldering.

A fly-wheel operated by hand carries cutting blades. The operator feeds the bars of solder down an incline, and they are sheared between a bead on the frame and those on the wheel.

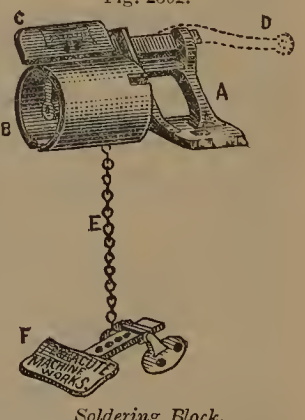
Sol'der-cut'ting Dies. Dies used in cutting out bars of solder in a press, eight in a block.

Sol'der-ing Fur'nace. A new form is adapted to burning coal oil, and is being extensively introduced as a heater for tinners' coppers, taking the place of the charcoal furnace.

Sol'der-ing Block. Used in soldering cans.

Fig. 2302 consists of an inclined frame, *A;* lever and "knife," *C;* expanding cylinder, *B;* chain, *E;* treadle and fulcrum, *F*, etc. A slot in the frame allows the use of different cylinders, from 1 lb. to 1 gallon, and their adjustment up and down, without changing the knife. A slot in the lever allows the knife to be set out for varying lengths of cylinders. Adjustments are also provided in the length of the chain, leverage of treadle, position of cylinder around its center, and "set" of the knife. The latter has a groove to prevent "tinning." The chain passes through the bench and hooks in at *D*. The action of the foot then raises the knife and the spring does the holding down.

Fig. 2302.



Soldering Block.

Sol'der-ing Frame. (*Sheet-metal Working.*) A clamp for holding the parts of a can in apposition while soldering.

Sol'der-ing I'ron. One recently invented has a platinum receptacle in which heat is instantaneously generated with air and petroleum vapor, or air and coal gas.

The Gem soldering iron is adapted to fit on an ordinary gas burner, with the copper up. The handle and tool are hollow, allowing the gas to escape through the point, where it may be ignited and the copper will be speedily heated.

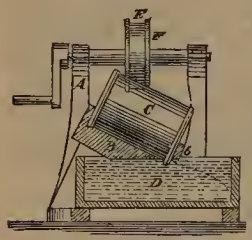
Soldering iron, gas heated * "*Scientific American Sup.*," 4106.
Soldering mach., *Howe* * "*Scientific American*," xxxv. 115.
Soldering tool, *Painter* . * "*Scientific American*," xlii. 178.

Sol'der-ing Ma-chine'. (*Sheet-metal Working.*) Howe's machine is for soldering the tops and bottoms of round cans. The cans roll along in an inclined trench, the edge passing along a shallow groove in which is melted solder. Page 108 of Bliss's catalogue (1881).

For soldering tin cans.

Fig. 2303 shows a machine especially suited for soldering the end seams of cans. *A* represents the frame of the machine, to which is attached a track, *B*, along which the cans are to be rolled. The track is flanged along its side edges to keep the cans *C* in place upon it, and has a side incliuation to cause the ends of said cans to rest upon the lower side flange *b'* as they are rolled along said track. The track *B* is slotted in the lower side of its middle part, along the flange *b'* to allow the end seam of the cans to project through into a solder bath *D*, placed beneath it in the frame, and in which the solder is kept melted by a furnace. The bath *D* is of such a length that the cans may make at least one entire revolutiou with their end seams in the solder. The track *B* is made with an upward incline at one end, down which the cans are rolled in passing from the machine. The cans *C* are rolled along the track *B* by an endless band *E*, which passes around the pulleys pivoted to the frame, and to one of which motion may be given by hand or other convenient power.

Fig. 2303.

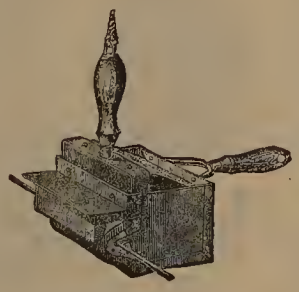


Soldering Machine.

Sol'der-ing Pot. For making joints in line wire.

When the upright handle is moved back, it allows a wire to be slipped down the slots, the joint being inside of the pot, which is partly filled with melted solder. The wire is pressed down on each side until it finds a secure lodgment in the bottom of the slots. The clamp is shoved forward so as to hold the wire in place, the arms of the clamp at the same time covering the slots and preventing the solder from running out. The pot is then tipped forward so as to cover the joint with solder, thus making a neat and well protected joint.

Fig. 2304.



Soldering Pot.

Sol'der-ing Tongs. A pair of flat nosed tongs used in brazing the joints of band saws. The saw is held in a scarfing frame, a film of solder placed between the scarfed edges which are lapped together, and then the heated tongs clamped upon them to melt the solder. See BAND-SAW HOLDER.

Sol'der Mold. A mold for running solder into any shape desired.

Sole. A recent inventor proposes to make boots with stone soles. A suitable quantity of clean quartz sand is mixed with a water-proof glue, and spread on a thin leather sole which is employed as a foundation. These quartz soles are said to be flexible and almost indestructible, while they enable the wearer to walk safely over slippery roads.

Sole Cut'ting Ma-chine'. The one shown in Fig. 2305 is adapted for cutting outsoles, insoles, heeling, counters, shanks, etc., and can be used with dies having handles or without. It has a circular revolving block; the die is fastened in a chuck over the block, and can be moved about as desired. The block is worn evenly by the coustant revolving motion; the wear is taken up by raising the screw under the machine.

Fig. 2305.

Sole Cutting Machine.

Sole Form'ing Machine'. One for rounding up shoe soles. A rounding up machine can shape 100 pairs of soles per hour.

The rounding is all done by one revolution of the knife, which at the same operation gives to the edge of the sole any desired bevel, and will work to patterns of any size or style, the changes being handily made.

Sole Leath'er Rol'ler. A machine for pressing leather stock into firmness, by passing between spring rollers. See Fig. 5309, p. 2244, "*Mech. Dict.*"

Sole Leath'er Strip'per. Adjustable blades or skivers for stripping the rough side of the leather.

Sole Mold'ing Ma-chine'. For shaping the cut sole to the shape of the last.

Sole Riv'et-ing Ma-chine'. The McKay riveting machine automatically cuts a rivet of the proper length, drives it, and clinches the point on the inside of the shoe. It clinches the rivet on a rotating horn, and thus makes the clinching certain. With the clinching rivet and the perfect length of the nail a thin insole can be used with safety. The rivets are corrugated so that they do not work up into the foot in wearing.

Sole Tile. A flat or bellying tile, according to requirements, for the bottom of sewers, muffles, or other objects in which the whole circumference is not in one piece.

Sol'id Plate Saw. A circular saw made of a single plate, as distinguished from a *segment* saw.

So'le-noid. An electro-dynamic spiral, having the conjunctive wire returned along its axis, neutralizing that component of the effect of the current that is due to the length of the spiral, and reducing the whole effect to that of a series of equal and parallel circular currents.

Sol'u-ble Glass. An alkaline silicate that is soluble in water, but remains unaffected by ordinary atmospheric changes.

The silicates of soda and potash differ from the other silicates grouped under the general name of glass in being soluble in water; hence they are known as soluble glass, liquid quartz, etc. While ordinary glass has been known from very ancient times, these peculiar compounds are quite new to us, having been accidentally discovered by the late Professor Fuchs, of Munich, in the year 1818, while experimenting with a view to the preparation of pure silica.

When soluble glass is applied to surfaces of plaster and limestone a chemical reaction takes place, resulting in the formation of silicate of lime. A vitreous surface is thus produced impervious to moisture and unaffected by atmospheric agents. Soluble glass is also used as a vehicle for mineral colors in a kind of fresco painting, known as stereochromy. The famous frescoes by Kaulbach, in the museum at Berlin, were done in this way. It is also entering into the preparation of paints for ordinary use.

One method of making artificial stone is by moistening fine sand with a solution of silicate of soda, pressing the mixture into molds, drying it and exposing it to a high temperature. The silicate fuses and cements the grains of sand together

into a mass resembling sandstone. Any desired color is imparted by the admixture of metallic oxides previous to molding. Thousands of tons of the silicate are consumed for this purpose in England. Another important application of soluble glass is in calico-printing, where it is now extensively used as a mordant. It is even more in demand in soap-making, for which it has advantages over resin on account of its alkaline character. It also enters into the composition of fire-proof cements for stoves and iron-work, and especially for putting up iron fronts for buildings.

Soluble glass, uses of . "*Scientific American Sup.*," 1417.

Son'do-graph. A recording sounding apparatus, which see, specifically; an invention of Lieuteuant Pinheiro, of the Brazilian navy, to give a continuous delineation of the bottom of the sea aloug the line on which it is operated.

See "*Telegraphic Journal*," vi. 426.

Soude a Dart. (*Surgical.*) A cannulated lithic instrument, having a flexible sound projected through it and out near the apex to collide with the stone. See Fig. 153, Part III., *Tiemann's "Armamentarium."*

Sound. Elliott's sound, modified by H. Leonard, is a new adaptation of a long surgical instrument, usually of metal, and partaking of the nature of a probe. It is used especially in making explorations in the bladder in search of stone. It is inserted through the urethra, and a peculiar click is heard when it comes in contact with a stone.

Simpson's sound (No. 8) graduated, and his (No. 9) telescope, for convenience in carrying, are also new modifications of the same instrument. To which may be added Dr. Helmutt's instrument for *supra pubis* puncture. Skene's uterine sound, *sonde de anal*, *sonde de belloc*, *sonde de Brisée*, *sonde à conducteur*, *sonde de saforest*, and *sonde* or pinchers of Hunter.

Sound Con-cen'tra-tor and Pro-ject'or. Hopkins' acoustic apparatus is a portable and adjustable whispering-gallery, having many useful applications. An air-tight drum or reflector, one head of which is rigid and the other elastic, is mouuted on pivots in a swiveled support, and is provided with a flexible tube having a mouth-piece and stop-cock at its free end. Two wires are stretched across the face of the reflector at right angles to each other, and support at their intersectiou a small plane mirror, the office of which is to determine the position of the reflector in relation to the direction of the sound.

A small ear trumpet is used in connection with the reflector, to increase the effect by gathering a portion of the sound that might escape the unaided car. The reflector is adjusted by looking through the ear-trumpet toward the small plane mirror, and moving the sound-reflector until the source of sound is seen in the mirror. The reflector is then focused by exhausting the air from behind the flexible head until the required degree of concavity is reached, indicated by the ease with which sounds may be heard in the ear-trumpet. The air is withdrawn from the reflector by applying the mouth to the mouth-piece.

Sound'er. Sir William Thomson's apparatus for deep-sea sounding while the ship is in motiou. See Sounding Apparatus; Flying Sounder.

Sound'er. (*Electricity.*) An alarm or call, made by closing an electric circuit.

The system of telephoning by means of beat of drum, long practiced in Africa, and called by the Cameroons *elliembic*, proceeds upon the principle of signaling by varying the beats according to a code. It perhaps would be too much to call it an alphabet code, and travelers who have noticed it do not seem to have been curious as to the nature of the system. The sound under favorable circumstances may be heard 2 or 3 miles.

The Mani-mani wooden portable signal drum known as the *clincufo* was shown at the Centennial in the Egyptian section, but the great drum *manyunjee* is a hollowed trunk of wood mounted on feet. It has sides of uneven thickness which give a different note aiding in giving variability to the signal. A similar drum from the Fijis is in the National Museum at Washington. See: —

Schweinfurth's "Africa," * ii. 24, 113.
Williams's "Fiji," * 129.
"Atlantic Monthly," * xxxix. 649.
Cameron's "Across Africa," * 231.
Duncan's "Western Africa," * 275.
Livingston's "Zambesi," * 98.
"Scientific American Supplement," 2737.

Sounder, India wires . * "*Scientific American*," xl. 408.
Theiler . . . . . * "*Telegraphic Journal*," vii. 63.
Simon & Son (gas) . * "*Telegraphic Journal*," vii. 205.
Otto (gas) . . . . * "*Telegraphic Journal*," vii. 173.
Deep-sea, *Thomson* . "*Min. & Sc. Press*," xxxv. 179.

Sound'-house. A marine alarm station from which audible alarms or signals are given in foggy weather. The apparatus are usually fog horns or sirens.

Sound'ing. Devices for sounding and gaging in surveys of the upper Mississippi; including stadia, water-gages, sounding stakes on sand-bars and trees, etc. See "*Report of Chief of Engineers, U. S. Army*," 1880, * ii. 1518.

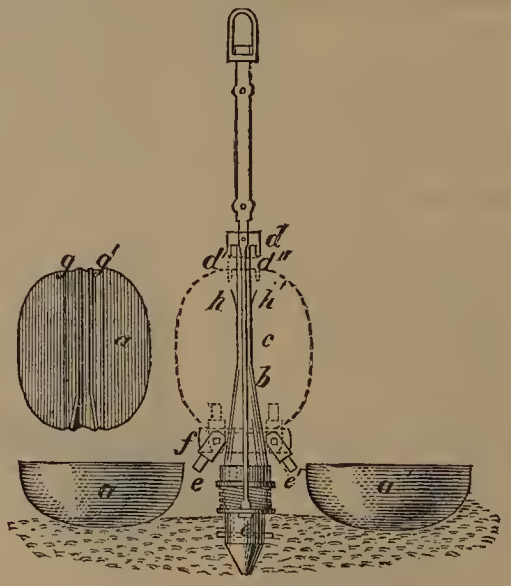
See Bathometer in "*Mech. Dict.*"

Sound'ing Ap'pa-ra'tus. A device for bringing up specimens of sea bottom.

In Admiral Sands' device a box is screwed into the bottom of the sounding lead and is secured thereto by a key. It has a conical point and is surrounded by a flanged sleeve pressed downward by a weak spiral spring. On striking bottom the point penetrates the ground and the flange on the collar forces it upward, exposing an aperture through which the mud, sand, or other material enters. When the lead is drawn up the spring reacts, closing the opening so as to prevent the specimen being washed out.

Admiral Sands has also invented an improved self-detaching sounding apparatus to be used in connection with the

Fig. 2306.



Self-detaching Sounding Apparatus.

specimen cup. The sinker is composed of two semi-ellipsoidal pieces *a a'*, having central grooves unitedly forming a tube through which the stem *b*, attached to the sounding line by a swivel, passes. A rod, *c*, carrying a collar, *d*, having downwardly projecting prongs, passes through the stem longitudinally and is attached to the sleeve of the specimen box *e*. When a souuding is made the two pieces *a a'* are fitted on the rod, being held by the prongs *d' d''* and pens *e e'* on the cross piece, *f*, entering the grooves *g g'*. When bottom is reached the upward movement of the sleeve on *e* raises the rod *c*, lifting out the prongs *d' d''* on the collar *d*, and the pieces *a a'* are thrown off by springs *h h'* on each side of the stem *b*.

In an instrument iuvented by Sir William Thomson for taking flying soundings while a ship is in motion, the essential idea is to measure the depth by the pressure of the water at that depth, which is effected by lowering a pressure gage with the lead line. Of the two forms of gage the first and that chiefly in use consists of a narrow glass tube closed at one end and opeu at the other. When it is lowered into the

sea the water entering the open end of the tube compresses the air column, diminishing its length in proportion as the water pressure increases, according to Boyles' well-known law. The height to which the water rises in the gage tube marks the limit to which the air has been compressed. The indicating mark is shown in various ways, — generally by lining the tube with a colored preparation that is removed as far as the water by pressure is driven up in the tube. The tube is of so narrow a bore that there can be no splashing of the liquid in it during the sounding process. The glass tube is guarded from shocks by a perforated metallic covering. The gage is provided at each end with a mounting containing a valve that opens inward under a definite amount of force As the tube descends into the sea, the lower valve is forced open, and the water enters the tube. When the hauling in is commenced, the lower valve shuts and holds the water that has entered it. On the other hand the pressure of the sea acting upon the upper valve causes it to open, allowing the air within the tube gradually to escape, obviating the danger of bursting from unequal pressure.

In order to ascertain the depth to which the tube has been sunk, a scale is provided, graduated in fathoms up to 100.

See Field's "*History Atlantic Telegraph*," Lieutenant-commanding Otway H. Berryman. See p. 2248, "*Mech. Dict.*"

See *Siemens* . . . . * "*Scientific American Sup.*," 368.
Thomson . . . . . * "*Scientific American Sup.*," 1632.
Leoccntre . . . . . * "*Scientific American Sup*," 3805.
Fo . . . . . * "*Scientific Amer.*," xxxvi. 182.
Rousset . . . . . * "*Scientific American*," xliii. 310.
de Luna e Cunha . . "*Scientific American*," xlii. 32.
Sir William Thomson . * "*Engineering*," xxiv. 329.
Sounding, deep-sea . . "*Scientific American Sup.*," 728.
Soundings instrument.
Sir William Thomson "*Telegraphic Journal*," v. 285.

Sound'ing Board. The sounding-board of pianos is made of spruce, which, with its alternate soft and hard grain, is recognized and used as the best material for the purpose. The beauty and volume of tone in an instrument depend materially upon the sounding-board, and mainly from its quality to react against the molecular vibration of its most delicate inner fibers. This latter process puts the air column surrounding the sounding-board into that vibration that to the ear is perceptible as "tone." The pressure of these several particles of the sounding board against each other, more or less determine not only the power of tone, but its susceptibility, and the singing quality also depends greatly upon it.

Sound'ing Lead. The sounding lead of M. Leoccntre, has a helical winged screw at the apex which rotates as the lead descends. On the axis of the helix is a bevel-wheel which transmits motion to a system of gearing, and the hands of two dials registering tenths of meters and meters respectively. The helix ceases to move when the lead touches bottom, and is loose on its axis as it is drawn up.

* "*Sc. American Supplement*," 3805.

Sound'ings Ther-mom'e-ter. The electrical balance thermometer, invented by C. W. Siemens of London, is intended to ascertain the temperature of the ocean at any depth, and is based on the principle that, as the electrical resistance of any metal conductor depends on the dimensions and temperature of the latter, we have only to find the law of the increase or decrease of its resistance for high or low temperatures to be able to determine the resistance from the temperature, or the temperature from the resistance. The deep-sea thermometer, constructed by him on the above principle, consists of a "resistance-thermometer," to which the sounding-line is attached, and of a battery, electrical bridge, and "balance-thermometer," to be used on board the vessel for determining the temperature indicated by the resistance-thermometer at any point of its descent or upon its reaching the bottom. The law of increase and decrease being known, a table is made up, by means of which to correct the deviations of the galvanometer into parts of a degree of temperature.

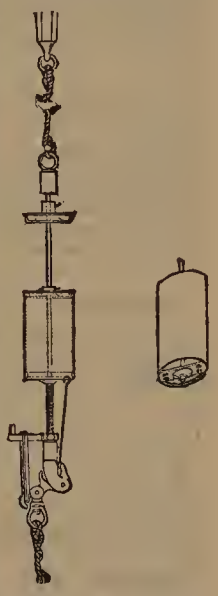
Trowbridge's deep-sea thermometer, "*Coast Survey Report*," 1858.

Six's self-registering thermometer, modified by Miller-Casella, is made in London.

Sound'ings Wa'ter Cup. A cup to bring water from the depths sounded.

An apparatus, designed to bring up one pint of water, consists of the following parts: A stem or spindle 0.5″ in diameter and 20″ in length, terminates at its lower end in a ring for the attachment of the sounding-lead, and at its upper end, in a slotted head, in which is pivoted the detaching trigger. This trigger is 3.5″ in length. It is pivoted at one end in the slotted head, and terminates at the other in a hook, curved upward, in which is placed one end of a rubber spring, as shown in the drawing. Near its middle the trigger carries a swivel for the attachment of the sounding-line; two curved lugs project from its lower side, and work, one on either side of the head of the spindle, so that when either is closed against it, by raising or depressing the free end of the trigger, the other will be open. For convenience of reference, the lug farthest from the free end of the trigger is designated the *rear* and the other the *front* lug. Below the slotted head, at a distance of 3″ from the pivot of the trigger, the spindle carries an arm 3″ in length, projecting in the plane of the trigger, and on the same side of the spindle with it. This also ends in a hook curved downward, over which passes the lower end of the rubber spring before mentioned. This arm slides on the spindle and is furnished with a set-screw, so that its distance from the trigger may be increased at pleasure. At a distance of 8.4″ below this arm the spindle carries a fixed disk 2.6″ in diameter, below this at a distance 4.5″, another disk 3″ in diameter. Passing freely over the former, and closing water-tight upon the latter, is a sliding cylinder 5.4″ in length. This cylinder is open at both ends, the upper end being furnished with a cross-bar and collar, working smoothly on the spindle, to guide the cylinder in sliding up and down. Attached to this cross-bar is a wire sling, ending in a loop, and of such a length that when this loop is placed over either of the lugs of the trigger, the lower end of the cylinder will come flush with the lower surface of the upper disk, as shown in the left-hand figure.

Fig. 2307.



Soundings Water Cup.

A spiral spring, coiled around the spindle between the projecting arm and the collar of the cylinder, tends to force the latter firmly down on the lower disk.

See "*Coast Survey Report*," by Lieutenant Collins, Appendix, No. 14.

The method of securing the specimens with the apparatus, shown in Fig. 2307, is as follows: —

A lead of sufficient weight (10 to 50 lbs., depending upon the depth of water and strength of current) is bent on close to the lower ring of the spindle, and a line, marked to fathoms, to the swivel on the trigger. If, now, the bottom-specimen is desired, the instrument is prepared by sliding up the cylinder and placing the loop of the sling over the *rear* lug of the trigger. A rubber spring is then stretched over the hooks of the trigger and projecting arm, this spring being of such a strength as to yield to the weight of the lead when the apparatus is suspended by the sounding-line, thus allowing the rear lug to close against the head of the spindle, preventing the cylinder from sliding down and closing on the lower disk.

Thus prepared, the apparatus is lowered into the water. On reaching the bottom, the weight of the lead being taken off, the rubber spring draws the hooked end of the trigger downwards, thus allowing the wire sling to disengage itself from the rear lug. The cylinder, forced down by the spiral spring, closes over the disks, and thus the specimen from the stratum in which it rested is secured and drawn to the surface

For the intermediate specimens the apparatus is prepared by placing the loop of the sling over the *front* lug of the trigger, and supplying a rubber spring of sufficient strength to hold the free end of the trigger down when the instrument is suspended by the sounding-line, thus keeping the lug closed The line is then made fast to the rail of the boat or vessel, at such a place as will allow the mark indicating the number of fathoms from which the specimen is desired to be at the surface when the line has run out taut.

The instrument is then put overboard and allowed to descend freely. As it reaches the desired depth the line is tautened, the rubber spring yields to the shock of the arrested motion, and the cylinder closes instantly, as before.

Sour Beer Core. This term is applied to a dry-sand core in which sour beer or ale has been used for the purpose of increasing the adhesiveness and strength of the sand when dried.

Sour Kraut Cut'ter. A machine for cutting cabbage for kraut. A stationary hopper, has a sliding board with a double edge knife which runs with alternate action, cutting each way. Adjustable screws regulate the thickness of the cut. A follower is used to feed the vegetables to the knife, and is also useful as a partition in cutting small quantities. The cutter is worked by a crank, with its accompanying gearing.

Spade. A variety of spades are used by whalemen.

Boat spade, to disable the whale by cutting its flukes.
Cutting spade, to peel the blubber from the carcass of the dead whale.
Half-round spade, to cut the "blanket" piece to allow the blubber hook to enter.
Head spade, to cut off the head of the whale.
Mincing spade, to cut the blubber small for trying out.
Throat spade, to cut off the head of the whale.
Wide spade, to cut the blubber in the rough, before mincing.

Spade Gun. Invented by Buskett of St. Louis. A detachable spade may be fitted to a socket in the butt-plate and form an efficient implement in intrenching. When not in use it is carried in a recess in the stock.

See . . . . "*Scientific American Supplement*," 1938.
Spade gun, *Buskett* "*Scientific American Sup.*," 1938.

Span'drel. An inner frame or border for a picture. A *mat*.

Spal'ling Ham'mer. An axe-shaped or chisel-edged hammer for rough dressing stone.

Span'ish Fox. (*Nautical.*) A seizing made by hand-twisting several yarns together and rubbing with hard tarred canvas.

Spank'er Gaff. (*Nautical.*) The gaff of the fore-and-aft sail, which is also called the driver; the aftermost sail of a ship or barque.

The *spanker boom* is the lower spar of the same sail.

Span'ner. A hoseman's wrench. The Skinner spanner has two equal arms, of which the rigid one has a pushing point slightly curved, while the pivoted arm has a drag hook on its end.

Spare An'chor. (*Nautical.*) An additional anchor, the size of the bower.

Spar'ger. A three nozzle self-acting revolving instrument for sprinkling paper, clothes, etc.

Spark Ar-rest'er. A wire or perforated screen to arrest the sparks that ascend smoke-stacks of locomotives, furnaces, etc.

Spark arrester, *Smith* . * "*Scientific American*," xxxvi. 70.
Davis . . . . . * "*Railroad Gazette*," xxiv. 97.
Graham, Br. . . . * "*Engineer*," l. 41.
Stamp . . . . "*Man. & Builder*," viii 9.
Garrett, Br. . . . . * "*Engineering*," xxx. 539.

Spark Net'ting. A wire cloth over the opening of a locomotive smoke stack, to arrest sparks.

Spawn'ing Screen. A device used in pisciculture to collect the spawn of fish. For list of United States patents, see FISH CULTURE.

Speak'ing E-lec'tric Tel'e-graph. See TELEPHONE.

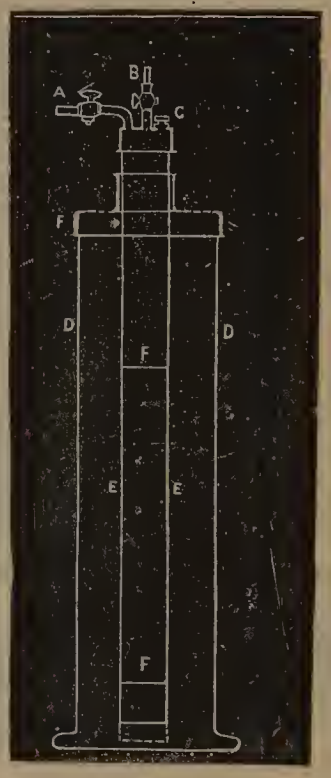
Speak'ing Tube Whis'tle. A modification of an intonating modulating steam whistle.

Spears. (*Fishing.*) Fish spears are barbed for securing the fish that are pierced thereby. They were used in very early days. Job speaks of them, as also do early Greek writers. They are of various makes adapted to the fish intended to be caught.

Spear Head. Spear heads are multiform both in shape and in the material of which they are made. They were generally made of stone or quartz by the aborigines of this country; although there was a notable exception with the (at least) partially civilized people who once resided in the neighborhood of the ancient copper mines of Lakes Superior and Huron. They possessed the means of tempering copper, that was lost with them, and notwithstanding all the researches of modern times, has never yet been rediscovered.

Spe-cif'ic Grav'i-ty Ap'pa-ra'tus. Fig. 2308 shows an apparatus for taking the specific gravity of coal and other gases by efflux through a fine opening in a thin plate of metal by Bunsen's method.

The apparatus consists of a glass jar, *D D*, having a perforated top with a collar or sleeve, through which passes a glass tube, *E E*, about 1″ diameter, open at the bottom, but closed at the top by a metallic cap having the connection and cock by which the gas is admitted at *A*; a thumb screw and place for thermometer, *C*, with the pillar cock *B*, on top

Fig. 2308.

Specific Gravity Apparatus.

of which is the exit opening through the thin metal plate. The glass jar *D D* being filled with water to the proper height, the tube *E* can be filled with gas or air at pleasure, thus forming a simple instrument, and one easily operated. Another form, equally simple, and very accurate, is Dr. Letheby's method; the apparatus consists of a glass globe about 6″ diameter, having engraved upon it its exact weight when full of air at mean temperature and pressure (a counterpoise weight being provided exactly equal to the weight of the globe when the air is exhausted); this globe is fitted with two cocks, one of which is attached to a gas pillar; to the other is attached a glass tube ½″ diameter and 7″ long, to which is suspended a thermometer, the end of the glass tube being fitted with a jet for burning the gas.

Goodwin's stop watch for density test of gas, "*American Gas-light Journal*," * July 3, 1876, p. 7.
Goodwin's minute clock, * *Ibid.*, p. 7.
Letheby's specific gravity apparatus for gas, * *Ibid.*, p. 7.

Goodwin's density and specific gravity apparatus, * *Ibid.*, p. 6.

Taylor . . . . * "*Scientific American*," xxxvii. 360.

Spe-cif'ic Grav'i-ty Bal'ance. The instrument employed in the office of the Constructor of Ordnance (U. S. A.) in the determination of the specific gravity of metals for cannon, is simply a form of the hydrostatic balance. It is shown in Plate I., accompanying Appendix I., c, to the "*Report of the Chief of Ordnance, U. S. Army*," 1877, and described on p. 394.

The Troemmer instrument for obtaining the specific gravities of large grained powder is a mercury densimeter and is described on p. 396 of above volume, and accompanying Plate II.

Description of the Du Pont, de Nemorirs & Co.'s machine, "*Ordnance Report*," 1879, Appendix I., Plate VII., and pp. 113-115.

Mohr's balance is for taking the specific gravity of liquids by a method which requires no calculation and but a small quantity of the liquid. The apparatus is shown in Fig. 5352, p. 2257, "*Mech. Dict.*"

Spe-cif'ic Grav'i-ty Bot'tle. A slight blown glass bottle of known capacity for obtaining the specific gravity of liquids by weighing measured quantities.

Spe-cif'ic Grav'i-ty Ma-chine'. A new densimeter submitted to the Academy of Sciences, Paris, by M. Gosse'in, is very simple in construction and operation. A wooden rule is suspended by a wire attached to some convenient point other than the central point. To the long arm a weight is attached sufficient to balance the body to be examined hung at the end of the other. The latter is immersed in water, and the weight on the longer arm is moved until the rule is again horizontal. A scale on this arm shows at once the density of the body at the point occupied by the weight.

Spe-cif'ic Grav'i-ty Scales. For determining the specific gravity of metals and other substances.

One form is adjusted to accurate balance with its counterpoise and loop removed from the beam, but with double baskets in position, and a vessel supplied with water. In determining specific gravities, the mineral or other solid to be tested is placed in the basket and the pan holder or counterpoise is adjusted to the position, established at a convenient distance from the fulcrum, and marking the extreme working length of the lever arm. One or more of the pans are placed upon the holder to counterbalance the weight of the mineral and a sufficient quantity of the granulated copper is placed in the pan to cause the beam to assume a horizontal position or to stand in perfect equilibrium. The mineral is then removed from the upper basket and placed in the lower basket where it is submerged in the water contained in the vessel. The counterpoise with its load of pans and granular material is then moved along the beam toward the fulcrum to a position where it just counterbalances the submerged mineral. This position corresponds with the specific gravity of the mineral, and the amount being indicated by the graduated scale, can be read off direct, thus giving at a glance the correct specific gravity without regard to the weight or quantity of the mineral or other substance under test.

Spec'ta-cles. Protective spectacles are made of various forms and material to protect the eyes of engineers, firemen, furnace tenders, masons, etc.

The use of such protection from snow has long since been recognized by the Esquimaux and other uncivilized and semi-civilized people.

"In order to avoid the terrible glare of the Arctic snow, we find the Esquimaux have invented snow spectacles. These consist of a piece of wood cut out in the shape of a spectacle; where the glass should be in ordinary spectacles we find two very fine slits. This apparatus I should think would be admirably adapted to drivers of railway engines, who have to encounter snow, wet, and hail, as the engine rushes through storms at express pace. The eye itself is entirely protected, while it gets a fair lookout through the slit in the wood. The ingenuity displayed by these hardy Esquimaux is very interesting and instructive." — *Frank Buckland in "Land and Water."*

Spectacle lens, annular, *Rowell*, * "*Scientific Amer.*, xl. 293.

Spec-trol'o-gy. The science of chemical analysis, by means of the lines of spectra, as modified by the volatilization of different elements.

Spec-trom'e-ter. For measuring the intensity of light.

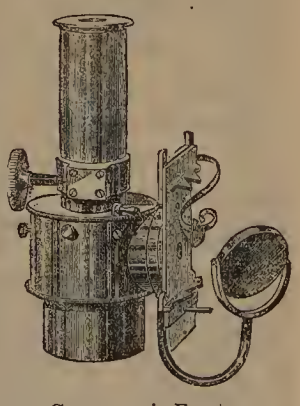
Prof. J. W. Draper describes in the July, 1879, issue of *Silliman's Journal* a new instrument, which he calls a "spectrometer," and which he proposes to employ to determine the intensity of a light, on the general principle that a light becomes invisible when it is in the presence of another light about sixty-four times more brilliant. He brings the spectrum of the light to be measured into the presence of an extraneous light of known illuminating power, and varies its distance from the instrument until its light is just sufficiently powerful to extinguish the spectrum. The suggestion is novel and valuable, and our readers are referred to the original communication for details. We remark incidentally that, in the use of this instrument, Prof. Draper found that the generally-accepted belief that the yellow is the brightest of the colored spectrum spaces is not true of the prismatic spectrum, and that the luminous intensity diminishes from that in both directions, above and below; that the "extinguishing flame" first extinguished the violet, then the other more refrangible colors in their descending order, and that the red was the last to persist. The red, he found, was invariably perceptible long after the yellow had disappeared. On diminishing the illumination, the red region of the spectrum first comes into view, the other colors following in the order of their refrangibility. He believes this apparent contradiction to be due to the action of the prism, "which narrows, and, as it were, condenses the colored spaces more and more as we pass toward the red, increasing the intensity of the light as it does that of the heat."

Spec'tro-scope. Christie's half prism spectroscopes have ordinary prisms that have been cut in half by a plane perpendicular to the base. In summing up the advantages of the half prisms: Suppose two slightly divergent rays of monochromatic light to pass through an ordinary prism, the angle of separation will not be changed so that the rays emerge at the same angle to each other which they had at entrance. But if two such rays fall perpendicularly upon a face of the half prism, the deviation of one ray in traversing the glass will be much greater than that of the other, and they will consequently emerge at a much wider angle. It is therefore claimed that the half prism is equivalent to a magnifier with cylindrical lenses.

Spectroscope, *Mouton*, Fr. "*Scientific American*," xxxvii. 40.
Ricco . . . . . * "*Scientific Amer.*," xxxvi. 184.
Thollon, Fr. . . . . "*Scientific American*," xli. 25.
Application of . . . "*Scientific American*," xxxv. 16.
Compound, *Thollon* . * "*Manuf. & Builder*," xii. 12.
In solar work . . . * "*Scientific Amer.*," xxxix. 242.
Measuring appa. for.
Reynolds . . . . * "*Scientific American Sup.*," 1946.
Uses of . . . . . "*Scientific Amer.*," xxxiv. 257.

Spec'tro-scop-ic Eye'piece. (*Optics.*) An adaptation of the spectroscope to the microscope for the examination of minute substances. It consists of a compound direct prism, fitted over a Huyghenian eye-piece, a slit and a supplementary stage upon which an object can be placed for comparison with another which is laid upon the stage of the microscope.

Fig. 2309.



Spectroscopic Eyepiece.

This piece of apparatus fits into the draw-tube of the microscope in place of the ordinary eye-piece, and by it accurate observations are made on the positions of

the various absorption bands in the spectra of various fluids, crystals, minerals, etc.

Spec'trum. The several colored and other rays of which light is composed, separated by the refraction of a prism or otherwise, and exhibited, either as spread out on a screen or in direct vision.

Spec'trum Scale. (*Optics.*) A slice of a crystal of quartz of a given thickness, cut parallel to its axis, placed between two Nicol's prisms, and giving a series of black bands. It is used as a standard for recording the position of the absorption bands in objects examined under the microspectroscope.

Spec'u-lum. The Storer vaginal speculum is so arranged that by a simple spring attachment at the side of the cusco bivalve, the blades may at once be disjointed, swung around back to back, and there fixed by a turn of the nut upon the screw traversing the handles, with the effect of giving a retractor equal in working facilities to that of Sims.

Neugebauer's speculum consists of four blades, with short, flat handles, all of which fit into each other compactly. Each blade resembles in shape that of Sims, differing but slightly in the curve and in not having its end rounded up. The main peculiarity of the instrument consists in the different blades being so proportioned to each other that any two consecutive sizes may be combined to form a tube; the lateral edges of the smaller are then inclosed within those of the larger.

The larger of the two selected is introduced posteriorly, as Sims' would be; the other enters beneath the pubic arch. The point of the latter, which at the outset is in the hollow of the opposite blade, gradually emerges as the blade is pushed forward.

It requires a little practice to enable one to perform this manipulation without inflicting some pain upon the patient. The result is a perfect tube through which the cervix may be readily inspected. The four blades form three complete specula of different sizes.

Amongst other specula not yet noted are those of Dr. E. B. Turnipseed, Sims' solid and wire instruments, Dr. E. W. Jenks', and Nott's instruments.

Speculum polisher, *Grubbs*, Br., * "*Engineer*," xlii. 160.

Speed. A leg or beam to which a drilling apparatus is attached. The word may not, in this connection, have a very extensive application, but is applied to the beams supporting the drilling tubes in submarine rock-drilling, as at the Rapide aux Galoups, St. Lawrence River.

The comparative speed of various saws and other machine tools are given as follows: —

Velocity of circular saws at periphery	6,000′ to 9.000′ per minute.
Rate of feed for circular saws	15′ to 60′ per minute.
Velocity of hand-saws	3,500′ per minute.
Velocity of gang-saws, 20″ stroke	120 strokes per minute.
Velocity of scroll-saws	600 to 800 strokes per minute.
Velocity of planing machine cutters at periphery	4,000′ to 6,000′ per minute.
Velocity of molding machine cutters	3,500′ to 4,000′ per minute.
Velocity of squaring-up machine cutters	7,000′ to 8,000′ per minute.
Velocity of wood-carving drills	5,000 revolutions per minute.

Speed In'di-ca'tor. An instrument for registering the speed at which an engine or machine may at any given time be traveling. Some of them are purely automatic in their construction, while others are in conjunction with their mechanical device operated by hand.

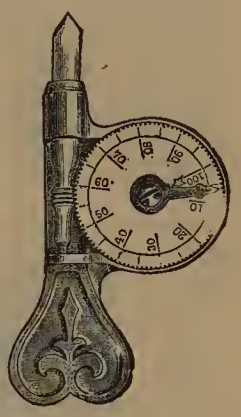
The Harding & Willis Indicator is designed to reveal by a glance at the needle, and without counting or using a watch, the speed at which the engine or machine is working. The small pulley is driven by a quarter-inch band from a second pulley placed on the shaft whose speed is to be indicated. The pulley drives a small shaft on which is fixed inside the casing a small fan with radial vanes. Alongside this fan is placed another one very delicately mounted on a small steel spindle that carries, but outside the fan-box, the indicating needle which works on the dial in the usual way.

The spiral spring always tends to bring the needle to the zero of the instrument, which is, of course, the lowest speed it is intended to indicate. When the fan is caused to revolve it has a tendency, on account of the air inclosed in the casing, to carry round in the same direction the other fan, together with the index-needle, and that against the resistance of the spiral spring. The greater the rate of the revolution to the greater extent is it possible for this fan to overcome the tension of the spring, so that the farther round will the needle be carried. The needle and fan are brought to rest as soon as the pressure on the fan vanes is balanced by the resistance of the spiral spring, the needle then indicating the increased velocity. The dial is indexed for each revolution per minute from 25 to 50, and by means of the eye the divisions may be subdivided to a quarter revolution.

The Union Boston Indicator (see Fig. 2310) is used to register the speed of any revolving shaft, pulley, or mandril.

To ascertain the number of revolutions of the shaft in a given time the point of the indicator is placed in the center of the shaft, and for each hundred revolutions the dial revolves once. Less than one hundred will be indicated by the pointer, which requires to be placed at the 100 before starting.

Fig. 2310.



Speed Indicator.

By a device on the face of the dial a person may feel with the end of the thumb how often it revolves without looking at it, thus enabling the operator to keep correct time.

The Westinghouse Railroad-speed Indicator is an apparatus for ascertaining and recording the speed of a train at any given instant, and by means of automatically constructed diagrams showing the fluctuations of the velocity caused by the applications of the brake.

The principle of construction consists in controlling the escape of water under pressure by means of a small valve loaded by the action of centrifugal force, the arrangement being such that the higher the speed at which the apparatus is driven, the greater will be the pressure exerted by certain revolving weights upon the escape valve, and the higher, therefore, the pressure maintained within the chamber with which this valve communicates, the chamber receiving a constant supply of water from the pumps.

A pressure-gage affixed to the chamber containing the water affords information as to the speed that is attained. The registrations are made on a paper drum similar to that used at meteorological stations to record the velocity of the wind. The heights of the recording lines on the diagram represent pressures on the accumulator of the speed indicator, and these pressures are proportioned to the squares of the speed.

There is a differential speed indicator adopted by all the ironclads of the French channel squadron.

Speed indica., *Butler*, Br. * "*Engineer*," xliii. 293.
Portable . . . . . * "*American Miller*," iv. 28.
Hobson, Br. . . . . "*Iron Age*," xix., April 12, p. 1.
Moss . . . . . * "*Scientific American Sup.*," 85.
Wier . . . . . * "*Scientific American Sup.*," 89.
Train, *Westinghouse* . * "*Engineering*," xxii. 203.
Ship's, *Normanville*, Br. . . . . * "*Engineer*," xlvi. 193.

Speed Meas'ure. Brown's measure (Fig. 2311), has a mercury reservoir and a radial communicating pipe. As the device is revolved by the machinery, the mercury, obeying the centrifugal force, passing up into the tube descends in the axial graduated tube, its sinking being the measure of the speed of rotation.

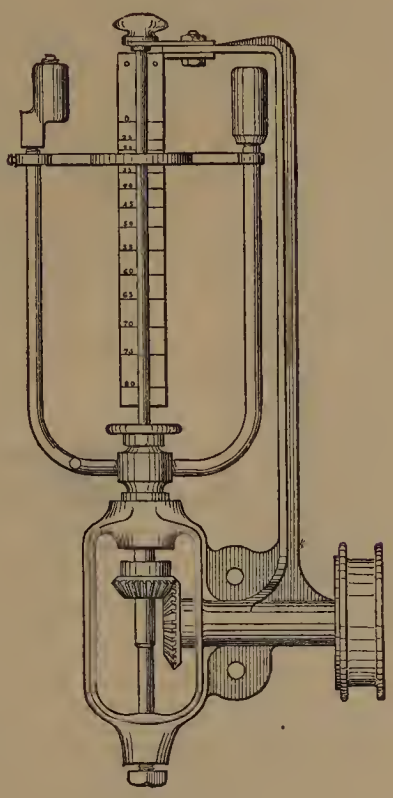
Speed Meas'ur-er. The speed measurer for trains, used at the brake trials at Cassel, Germany, in 1877, consisted mainly of (1) contact instruments, (2) reading instruments, and (3) reading-off instruments.

The contact instruments were fixed by the side of the rails at 33⅓ meters apart along each trial ground, and were all in electric communication with the reading instrument, which, with the reading-off instrument, was fixed in a room of the Buntershausen station.

The apparatus is described in

Speed measurer for trains, Ger., * "*Engineer*," xliv. 235.

Fig. 2311.



Speed Measure.

Speed Re-cord'er. Miller's speed recorder is an indicator of the speed of trains, their stops and delays (necessary and unnecessary), registering the same for reference. See under STEAM GAGE, *infra.*

See, also, "*Scientific American Supplement*," 1457.

Theiler, Br. . . . . * "*Engineering*," xxiv. 155.
Westinghouse . . . . . * "*Engineer*," xliii. 10.

Speed Reg'u-la'tor. Hübner's governor or speed regulator for railway horse powers is intended for regulating such powers in small factories, etc.

The rim or circle is fastened on the power behind the belt wheel, leaving the shaft in the center. The hub has arms attached, with weighted balls, friction blocks, and a stud with a small coiled brass spring, adjustable with a thumb-screw at the end to regulate the amount of speed needed. As the velocity of speed throws the balls out the friction blocks are pressed against the rim, and act as a brake, but as soon as machinery is applied and takes the power, the balls drop back and relieve the breaking.

See, also, "*Scientific American*," xlii. 245.

Speed regulator for light machinery, * "*Engineer*," xlix. 606.

Speed'y-cut Boot. See HORSE BOOT.

Spel'ter-Sol'der Al-loy'. A good solder for copper and iron is composed of three parts zinc and four parts copper.

A softer solder that is used for ordinary brass work is composed of equal parts of zinc and copper.

A very hard but fusible solder is composed of two parts zinc and one part copper. This solder is so hard and brittle that it can be easily crumbled in a mortar when cold.

The two first solders are first alloyed and cast into ingots. The ingots are allowed to cool in the mold, and then reheated nearly to redness upon a charcoal fire, and are broken up on the anvil, or in a mortar, into a finely granulated state, for use.

Spelter furnace . * "*Scientific American*," xxxix. 402.

Spen'ce's Met'al. A metallic compound consisting of a metallic sulphide mixed with sulphur.

Used for pipe-joints, calking metallic joints, etc.

Announced in a paper read by Dr. Cole before the Society of Arts. Reported in "*Engineering*," 1880, and repeated in "*Van Nostrand's Mag.*," xxii. 371.

Sperge. A charge of distiller's wash. *Muspratt.*

Sphe're-om'e-ter. A sphere-measurer, adapted to measure the radius of a sphere, invented by the French optician De La Roue, to measure the radii of lenses.

This instrument is valuable to opticians, for if they know the radii of the spherical surfaces of a lens, and also the refracting power of the glass of which the lens is composed, they can estimate the general action of the lens on rays of light that fall upon it, and thus arrive at a knowledge of the focal length of the lens.

Sphere Turn'ing Lathe. A lathe for turning spheres; mechanically adapted to the production of a perfect lens.

Its principle is based on the fact that the section of a true sphere at any part is always a circle.

Sphyg'mo-graph. An instrument for indicating the movement of the pulse.

The nature of the circulatory system and even the functions of the arteries and the veins and the nature of the blood were long enigmas.

Praxagoras of Cnidus (300 B. C.) wrote on the pulse, showing that it is a measurer of the force of disease, and discussed the difference between arteries and veins.

Theophilus of Alexandria ("*De Corporis Humani Fabrica*") wrote on the pulse and attributed it to the contraction of the heart.

Erosistratus of Alexandria described the action of the heart, but supposed that the arteries carried air and the veins blood. He noticed the lacteals, but did not understand their function.

Servetus of Geneva (burned 1553), observed the smaller circulation of the blood, that from the head through the lungs and return.

Rialdo Colombo ("*De Re Anatomica*," 1559), successor of Vesalius, at Padua, described the pulmonary circulation.

Fabrizio of Padua (*Acquaperdenti*), 1562, noticed that the venal valves all opened towards the heart. Harvey was one of his pupils.

Galileo (fl. 1610) invented an instrument for rendering the arterial pulsations visible. Placing one end of a light mirror upon the artery leading to the thumb and the other upon a fixed object, he caused the image of a sunbeam reflected from the mirror upon an opposite wall to vibrate in unison with the pulse. A remarkable similarity exists between this and Sir Wm. Thomson's galvanometer. No apology is needed for naming them together.

The idea was revived by Wenham (Engl.) ("*English Mechanic*," xxiv. 20) who proposed to use a small mirror laid on the pulse and reflecting upon a wall or screen.

Aselli of Milan ("*De Venus Lacteis*," 1627), discovered the function of the lacteals which pour the chyle into the blood.

Santorio of Padua ("*Commentarius in Primum fera Primi Libris Canonis Avicennæ;*" Venet, folio, 1626), invented an instrument for measuring the force of the pulse.

Andrea Cæsalpin ("*Exercitatio Anatomica de Cordis et Sanguinis Motu*," 1628) seems prior to his published work to have understood the greater or systematic circulation. A monument has been erected to him in Rome as "the discoverer of the circulation of the blood," and a table attributing the discovery to him has been attached to the portals of the University of Pisa, where he once taught.

Harvey, in 1616, made the discovery of the nature of the arterial and venal circulations and the double circulation. The doctrine was first publicly discussed and combated as Harvey's, in Europe as well as in England. Within a century of the death of Harvey, the father of modern physiology, Haller, revived the whole controversy, and gave a verdict in favor of the English physician. Holding that the true discoverer of any truth is he who draws it from its sources "at his own risk and by his own meditations, and establishes it by arguments so forcible that they convince those who are longing for the truth," Haller decided that "not to Cesalpinus, on account of a few utterances of obscure meaning, but to Harvey, the laborious author of numerous experiments and the expounder of all the arguments which, in his time, could be advanced, belongs the immortal glory of the discovery of the circulation of the blood."

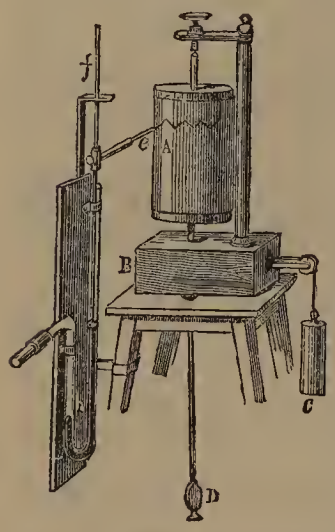
An apparatus for measuring the force due to the arterial circulation in a living animal, was made by an English physiologist, Stales, during the past century.

He was followed by Ludwig, the present professor of physi-

ology at Leipsic, who contrived a registering instrument, Fig. 2312, to record the variations of pressure of the blood circulating in the arteries.

A tube was applied to the artery of the animal and the varying force of the blood, acting upon a column of mercury, caused a float to rise and fall and a pencil attached thereto traced upon a turning cylinder each oscillation of the manometer.

Fig. 2312.



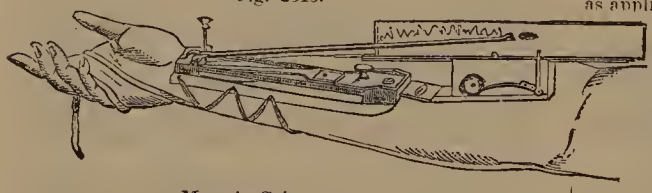
Ludwig's Register of Arterial Pulsations.

This is said to be the first registering instrument constructed for the uses of physiology.

The *sphygmoscope* proper (*σφυγμός*, the pulse, *μέτρον*, to measure) that is, the instrument applied to the pulse, was invented by Professor Vierardt, of Tübingen. It was not a *sphygmometer*, or *sphygmograph*, for it neither counted nor recorded the pulsations, but its indicator oscillated in the fashion of a pendulum and afforded a means of counting by the eye instead of by the strokes of the pulse against the finger-ends.

The *sphygmograph* first attained definite shape in the invention of M. Marey. A view of the apparatus detached is shown in Fig. 5380, p. 2365, "*Mech. Dict.*," but its operation will be more readily understood from viewing it in position, Fig. 2313.

Fig. 2313.



Marey's Sphygmograph.

It may as well be mentioned here that instruments which graphically indicate the beating of the heart are applied to the chest, and entitled CARDIOGRAPHS.

Marey's sphygmograph employs a spring pad to rest upon the pulse and the degree of pressure is obtained by means of a regulating screw. This spring device is so light that it follows faithfully the movements which are communicated to it by the exterior pulse, due to the swelling and collapsing blood vessel beneath the skin. These movements are so slight that it becomes necessary to amplify them, and this is done by translating the motion of the spring to a very light wooden lever near the axis of its movement. The outer end of the lever carries a scriber which records on a moving strip of paper, movements many times greater than those received from the artery. Extreme lightness of the lever and the union of the lever with the spring, the movements of which it records in much greater amplitude, are the necessary conditions for a good trace.

The sphygmograph reveals many delicate shades of difference in the pulse, showing the suddenness or slowness of the impulse, its strength or weakness, its length or brevity. The degree of abruptness is indicated by the angle of the line of trace departing from the base or horizontal line. The strength is shown by the amplitude of the excursions of the pencil; the duration, which is tantamount to the rate of repetition, is shown by the position occupied by each beat upon the length of the trace.

The ribbon is moved by clock-work.

The same rules govern as in the instruments for graphically representing articulate sounds, as mentioned under PHONAUTOGRAPH, p. 1678, "*Mech. Dict.*," and illustrated under TELEPHONE, *Logographic curves*, Fig. 6257, pp. 2514, 2515, *Ibid*

The sphygmograph of Marey was followed by several devices for the same purpose, notably by that of Holden, described in his work "*On the Sphygmograph*," Philadelphia, 1874. He there credits Vierordt with the suggestion of the instrument, and refers to Professor Burdon Sanderson's improvements on Marey.

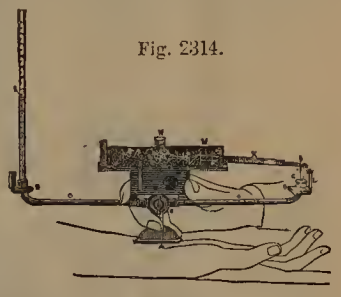
Holden's sphygmograph differs from Marey's (1) in the form of the pulse-spring, which is made to partially embrace the artery instead of merely resting upon it; (2) in conveying a to-and-fro lateral instead of a vertical motion to the tracing pencil; (3) and in a watch-spring device for registering the pressure upon the artery.

See also Dr. Sanderson's "*On the Sphygmograph*," an English work.

The sphygmograph of Dr. Keyt, of Cincinnati, Ohio, illustrated and described in the "*New York Medical Journal*" (xxiii. pp. 26 *et seq.*, plate opp. p. 30), and shown in Fig. 2314, has points of resemblance to the Marey instrument, but still more numerous novel features.

The base or receptacle *a* is made of thin brass, semi-circular above, but with a free, oblong edge below, over which is stretched an elastic rubber membrane which, when in use, lies upon the pulse and partakes of its movements. In the neck of the chamber *a* is a tube, *b*, which has a three-way stop-cock and two lateral branches, *c c*, leading to the two extremities of the instrument. From one of these rises a graduated glass tube in which the liquid affected by the beating of the pulse against the membrane rises and falls in a degree proportioned to the force of the arterial impulse and at a rate, of course, coincident therewith.

Fig. 2314.



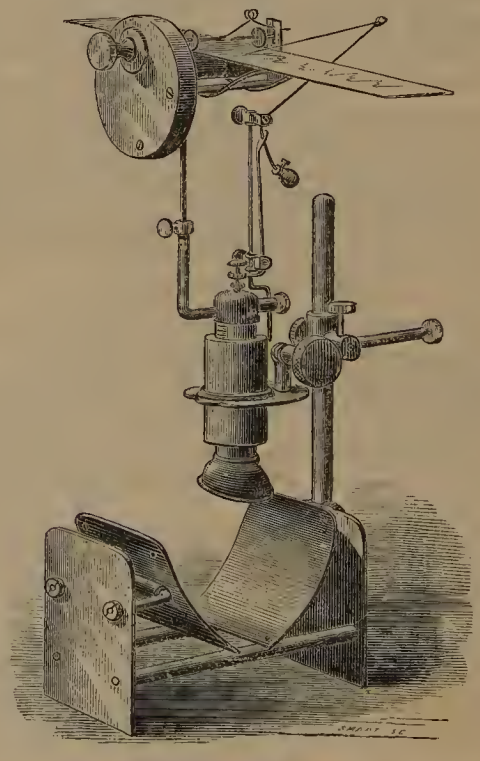
Keyt's Sphygmograph.

At the end of the other tube, *c*, is a small cup, *g*, in which is a disk resting on the fluid in the tube, and from the disk rises a stem, *j*, supporting a lever, *k*, on whose free end is the pencil which makes the trace upon the smoked glass slide which is traversed by clock-work.

The instrument weighs 8 oz. when filled with the liquid, and is 12″ long, 4″ high. The graduated tube folds down to place the instrument in its case. It is usually held by the hand of the observer, as in the illustration, which shows it as applied to the radial artery. Much fuller details of construction are given in the "*New York Medical Journal*," above cited, and republished in * "*Scientific American Sup.*," 117, 118

Pond's sphygmograph, shown in Fig. 2315, is an improvement upon the *Sphygmoscope*, shown in Fig. 5381, "*Mech. Dict.*" The instrument is capable of adaptation as a sphygmograph, cardiagraph, myograph, or pneumograph, but in the figure is shown as

Fig. 2315



Pond's Sphygmograph.

adapted to the pulse of the forearm, which should lie in the cradle below. The tube, with an elastic membrane at its lower end, rests upon the pulse, and the pulsations, acting upon the membrane, are transferred to the liquid contents of the tube raising the piston; these motions are transferred to the stylus, which makes traces upon the smoked glass plate, which is traversed at right angles to the line of motion of the style. The combination of the two motions gives the graphic representation.

By the sphygmograph we may read the pulse as follows: —

The *amplitude* of the pulse is shown by the height of the undulations.

The *regularity* of the pulse is shown by the rhythmic succession and equal stages and development of the undulations.

The *frequency* of the pulse is shown by the rapidity of succession of the undulations.

The *quickness* of the pulse is shown by the suddenness of the ascent of the undulations.

The *compressibility* of the pulse is shown by the degree of elevation at which is displayed the maximum amplitude of the undulations.

The *tension* of the pulse is shown by the mark of compressibility in connection with the rate and manner of descent of the undulations.

The *dicrotous* of the pulse is shown by the distinct break in the line of fall, or, as frequently seen, a second rise from the line of fall, or bottom of the undulations.

Minor sphygmographic curves are at times shown by the lesser interruptions in the fall of the undulations.

It is suggested that an enlarged shadow of the undulations might be projected on a screen in a clinical theater; or photographed upon a prepared surface moved as in the THERMOGRAPH or BAROGRAPH, Fig. 6350, p. 2546; Fig. 569, p. 234, "*Mech. Dict.*"

See following United States patents: —

203,548 *A. T. Keyt*, sphygmometer, May 14, 1878.
167,785 *W. R. Pond*, sphygmoscope, Sept. 14, 1875.
161,821 *W. R. Pond*, sphygmoscope, April 6, 1875.
205,412 *E. A. Pond*, sphygmograph, June 25, 1878.
183,205 *E. A. Pond*, sphygmograph, October 10, 1876.
232,105 *W. H. H. Barton*, sphygmophone, Sept. 14, 1880.

Sphyg-mom'e-ter. An instrument for measuring the force, rate and other characteristics of the pulse. The subject is considered under SPHYGMOGRAPH, which see. See also PULSOMETER, page 1825, "*Mech. Dict.*," and article in —

"*Manufacturer and Builder*" . . . . . xii. 208.

Sphyg'mo-phone. For rendering audible the sounds of the pulse beats.

In Dr. Richardson's sphygmophone, a microphone is added to a Pond sphygmograph. A thin plate of platinum is mounted on a slip of talc which is placed in the sphygmograph as if for a tracing of the pulse. One terminal from a Leclanché cell is connected to the slip of platinum on the talc, and the second terminal to a terminal of the telephone. The other terminal of the telephone is connected to the metallic rod of the sphygmograph which supports the talc.

The instrument is placed on the pulse in the ordinary way, and the needle thrown back till a good pulsating movement is secured. The needle is then thrown over to touch the platinum strip, which it traverses with each pulse movement and completes the connection of the telephone with the battery; this passing over the metallic plate causes a distinct series of sounds corresponding with the movements of the pulse. The sounds heard are three in number: one long sound and two short, corresponding to the systolic push, the arterial recoil, and the valvular check.

The sphygmophone of Dr. Stein, of Frankfort, consists of a piece of watch-spring, five centimeters long, which is soldered to a small brass frame, and is provided at its free end with a gutta-percha knob which is placed against the pulse or chest. The knob carries a platinum contact plate, opposite to which is a platinum contact point, and these two contacts are connected in circuit with two Bunsen cells and a telephone. The movements of the pulse (for instance) establish contact between the point and plate, and so make and break the circuit. The result is that the natural rythm is heard aloud in the telephone.

See notices in —

"*Manufacturer and Builder*" . . xi. 96.
"*Eng. and Mining Journal*" . . xxviii. 128.
"*Telegraphic Journal*" . . . . . vii. 120.
"*Iron Age*" . . . . . xxiv., July 3, p. 15.

Sphyg'mo-scope. An instrument for rendering visible the beats of the pulse.

Such was made by Galileo, by means of a mirror and beam of light; see SPHYGMOGRAPH, where also is mentioned the device of Prof. Varardt, of Tübingen.

See also Pond's Sphygmoscope, Fig. 5381, page 2265, "*Mech. Dict.*" This instrument has since been made a recording instrument, and is further illustrated under SPHYGMOGRAPH, present volume.

Spic'u-lar. A dentist's long curved-nose forceps, for removing small fragments of bone, etc.

Spi'der Hoop. (*Nautical.*) A brass hinged hoop made to clasp around the mast of a vessel, with attachments for the fastening of the futtock-shrouds.

Spie'gel. (*Metallurgy.*) *Spiegeleisen*, "mirror-iron." A crystalline variety of white cast-iron containing from 2 to 10 per cent. of manganese, and a large amount of combined carbon. It is excessively hard and lustrous, and is used chiefly in the Bessemer and Siemens-Martin processes. See below.

Spie'gel-ei-sen. Manganiferous cast-iron. See FERRO-MANGANESE, SPIEGEL, and SPIEGEL IRON. See also *Comptes Rendus*, April 5, 1874.

Micro-structure of . . * "*Scientific American Sup.*," 2668, 2738, 2761.

Spie'gel I'ron. Mirror iron.

In German "Spiegeleisen," which means "mirror iron," is thus called because its fracture shows flat shining surfaces, reflecting light like pieces of mirrors. It is of all iron the richest in carbon, and also the most brittle and hardest, — no steel tool will make an impression on it. It is very fusible, and it is principally used at present in the manufacture of Bessemer steel. In this process most of the impurities are removed from the melted mass by forcibly blowing air through it, which burns them out, but also too much of the carbon, so that at the last stage of the process the iron is reduced to a condition of being almost equivalent to wrought iron, and cannot be poured, the temperature, high as it is, being insufficient to keep wrought iron in the liquid state. Melted spiegel iron is then introduced, which at once combines with the mass under the evolution of a large flame; the iron becomes then at once as liquid as water, and is poured in the molds to make ingots. Spiegel iron is also used to make safes burglar-proof; as an interior filling for this purpose it is cast between sheet-iron lining. It also possesses the curious property of being less magnetic than any other kinds of iron; it is less attracted by the magnet than other kind of iron, and strongly resists efforts to magnetize it, which is contrary to the property possessed by wrought iron, which takes magnetism easily but also loses it easily; while steel takes it with some resistance, but when once it is magnetized it holds it. We have a spiegel iron in this country; it is made from the New Jersey Franklinite ore, and was at first called Franklinite iron. It has commenced to be universally used in place of the spiegel iron, thus far imported from Germany, and will probably supersede it, if it has not already done so.

Spike. The following table shows the amount of spikes to a mile of railroad: —

Size measured under Head.	Average Number per Keg of 150 lbs.	Ties 2′ between centers, 4 Spikes per Tie, makes per Mile:	Rail used, Weight per Yard.
5½ × 9-16	280	5,670 pounds = 38 kegs	45 to 70
5 × 9-16	300	5,170 pounds = 35 kegs	40 to 56
5 × ½	340	4,660 pounds = 31 kegs	35 to 40
4½ × ½	400	3,960 pounds = 27 kegs	30 to 35
4 × ½	450	3,520 pounds = 24 kegs	28 to 25
4½ × 7-16	510	3,110 pounds = 21 kegs	25 to 30
4 × 7-16	540	2,940 pounds = 20 kegs	
3½ × 7-16	675	2,350 pounds = 16 kegs	20 to 25
4 × ⅜	760	2,090 pounds = 14 kegs	
3½ × ⅜	890	1,780 pounds = 12 kegs	16 to 20
3 × ⅜	930	1,710 pounds = 11⅓ kegs	

Spike Ex-tract'or. An iron lever with a

fulcrum hook beneath to clasp the rail and a claw hook at its lower extremity to lift the spike by the head.

Spike extractor . . . . . * "*Engineer*," xliv. 413.
Devine . . . . . * "*Engineer*," xli. 42.

Spil'liard. (*Fishing.*) A floating trawl line.

Spin'ner. (*Fishing.*) A trawling spoon-bait which revolves as it tows abaft the boat.

A flanged attachment in connection with a fish-hook to cause a lively motion of the hook and bait.

(*Wool Manufacture.*) Avery's continuous wool-spinner resembles the original Hargreave spinning machine. The roving is fed from the spool by a revolving drum driven from the pulley-shaft, and is delivered to peculiarly-constructed wheels, which seize it at the proper moment and release it again as the spinning occurs, and the required draught is thus given. The drum and the cage-wheel with which it acts revolve at the same speed. The roving, as delivered, hangs down loosely until sufficiently twisted, when the next motion delivers a new supply and takes up that already twisted.

Spin'ning. (*Fine Art Metal-working.*) A mode of forming silver and other ductile metal into shapes. A disk of metal is placed in the clamp in the lathe, and while revolving is pressed by a burnisher which spreads the metal, giving the disk a cup-like form, for instance. Other pieces are worked in a similar way, and form parts such as cover, body, foot, of a pitcher or what not. Fig. 5412, "*Mech. Dict.*"; * "*Scientific American*," xxxvi. 290, Fig. 9.

Spin'ning, Tex'tile Ma-chin'er-y, Fab'rics, Sew'ing, Knit'ting, etc. See under the following heads: —

Aino cloth.
Algerine.
Alpaca.
Alpaga.
Alpine.
Anacostra.
Armure.
Arras.
Australian crape.
Baize.
Balling machine.
Bandekin.
Banding machine.
Banding ring.
Barége.
Basket.
Batavia weave.
Beaming machine.
Beetling machine.
Biarctz.
Bleachery.
Block.
Blocker.
Blocking machine.
Bobbin winder.
Bolivar.
Bombazine.
Bourdalisandre.
Braiding machine.
Brilliantine.
Brim pouncing machine.
Brim stretcher.
Brocade.
Brushing machine.
Buckram.
Burlaps.
Burring machine.
Button making.
Calender rolls.
Calico.
Calico printing.
Calico rolls.
Cambric.
Camel's hair.
Cam loom.
Cannel.
Card and combing machine.
Card guider.
Cardigan jacket machine.
Carding machine.
Carpet loom.
Carpet machinery.
Carpet matching and measuring machine.
Carpet winder.
Cashmere.
Cashmere de bege.
Chain loom.
Chain tappet loom.
Challis.
Chambery gauze.
Chinchilla.
Chintz.
Circassienne.
Circular knitting machine.
Circular ribbing machine.
Cloth cutting machine.
Cloth dressing machine.
Cloth drying machine.
Cloth finishing machine.
Cloth folding machine.
Cloth measuring machine.
Cloth press.
Cloth pressing machine.
Cloth shear.
Cloth shearing machine.
Cloth stretching machine.
Cloth teasling machine.
Cloth winding and measuring machine.
Cocoon winder.
Combing machine.
Cone.
Cop reel.
Cop winding machine.
Cord making machine.
Cordwain.
Corset loom.
Cotton.
Cotton cylinder.
Cotton machinery.
Cotton opener.
Cotton process.
Cotton spinning.
Cramoisy.
Crape of Spain.
Cretonne.
Crown pouncing machine.
Cuff frame.
Cypresse.
Damask.
Darner.
Darning machine.
Debaige.
Degumming machine.
Delaine.
Diagonal.
Diaper.
Dimity.
Dobby machine.
Doubling winding machine.
Drag.
Drap d'Alma.
Drap d'Alpes.
Drap de Nationelle.
Drap d'Été.
Drawing-frame and ribbon-lap machine.
Drugget.
Drying chamber.
Drying machine.
Duck.
Dunging vat.
Dycing.
Dye vat.
Embossing machine.
Embroidering machine.
Épingline.
Épinglé.
Excelsior.
Fabric.
Faller.
Faller machine.
Fancy board loom.
Feather plush.
Felt.
Felting machine
Felt mat.
Finishing press.
Fireproofing cloth.
Flat-rib knitting machine.
Flax baking machine.
Flax comb.
Flax loom.
Flax machinery.
Flax silk.
Flax spinner.
Flock.
Forming machine.
Foulard drying apparatus.
Foulard machine.
Fricze.
Fulling mill.
Fur blowing machine.
Fur hat machinery.
Fustian.
Gas cloth.
Gauze.
Gingham.
Gingham loom.
Girth stretcher.
Glove making.
Glove sewing machine.
Grenadine.
Grisaille.
Hair cloth.
Hand loom.
Hank dyeing machine.
Hardening machine.
Harness.
Hatchel.
Hat.
Hat block.
Hat blocking machine.
Hat finishing lathe.
Hat forming machine.
Hat lining sewing machine.
Hat machinery.
Hat press.
Hat shaping machinery.
Hat stretcher.
Hat sweat.
Headstock.
Heddle.
Hemmer.
Hemp.
Hemp softening machine.
Henrietta cloth.
Hernani.
High loom.
Hosiery seaming machine.
Imperial silk serge.
Indigo mill.
Ingrain.
Intermediate spinning frame.
Ironing machine.
Jacquard loom.
Jean.
Jupon.
Jute.
Jute machinery.
Kalameil.
Kerseymere.
Knitting machine.
Knot.
Lap doubling machine.
Lap machine.
Leather cloth.
Linen machinery.
Linsey-woolsey.
Lint.
Llanos.
Loom.
Loom stopper alarm.
Machine twist.
Luster.
Mandarining machine.
Manteau.
Matelasse.
Melange.
Merino.
Merino tulle.
Mexican cloth.
Mohair.
Mohair glacé.
Moire.
Moulleton.
Mousseline.
Mousseline de bege.
Mozambique.
Mule.
Muslin.
Nankeen.
Nosing motion.
Oiler.
Opener.
Opening machine.
Opener lapper.
Opus consutum.
Overpick loom.
Palamporé.
Paramatta cloth.
Pattern chain.
Plaiter.
Plaiting machine.
Pongee.
Porcupine.
Positive motion loom.
Pouncing machine.
Presser foot.
Printing.
Print-washing machine.
Ply.
Punjam.
Ramie.
Ramie fiber machine.
Rayne, cloth of.
Rep.
Retting.
Rib-fabric knitting machine.
Rib-top machine.
Ring and traveler throstle frame.
Rolling machine.
Rope.
Roving frame.
Roving reel.
Ruffler.
Sail Sewing machine.
Salampore.
Sample cutter.
Sarsnet.
Satin.
Satine.
Satinet.
Satinet loom.
Satin weave.
Scouring.
Scutcher.
Seaming machine.
Selvage.
Sendal.
Serge.
Serge armure.
Sewing machine.
Sewing machine, dress protector for.
Sewing machine shuttle.
Sewing machine treadle.
Sewing silk.

Shaping machine.
Shaving machine.
Shawl loom.
Shearing machine.
Shirt frame.
Shirt knitting machine.
Shoddy machine.
Shuttle race.
Sicilienne.
Siclatome.
Silk.
Silk degumming machine.
Silk dyeing machine.
Silk loom.
Silk machinery.
Silk reel.
Silk softening machine.
Silk spinner.
Silk spooling machine.
Silk spooling and measuring machine.
Silk stretching machine.
Silk thread.
Silk-washing machine.
Silk waste.
Silk winder.
Silk-worm nursery.
Smdon.
Singeing machine.
Skein-torsion machine.
Sleeve frame.
Sleeve machine.
Sliver guide.
Sliver lap machine.
Slubbing frame.
Slubbing machine.
Snugger.
Spinner.
Spinning.
Spinning head.
Spinning machine.
Spinning mule.
Spinning ring.
Spinning roller.
Spool holder.
Spooling machine.
Spool printing machine.
Spool winding machine.
Stamper.
Steam chamber.
Stiffening machine.
Stop motion.
Straw braid.
Straw hat.
Sweat-lining sewing machine.
Sweat rolling machine.
Sweat sewing machine.
Taffeta.
Taffetas.
Taffetas armure.
Take-up.
Take-up motion.
Tamise.
Tamise rep.
Tapestry carpet.
Tars, cloth of.
Teasel.
Teaseling machine.
Tentering machine.
Textile fabrics.
Thread dressing machine.
Thread waxing machine.
Throstle frame.
Tin-box loom.
Tip stretcher.
Tissue.
Tissue paper.
Tissue Silk.
Toile-de-Saxe.
Tom-tom.
Top.
Tuck creaser.
Tuck marker.
Tulle.
Turenue cloth.
Turning-off machine.
Turquoise.
Twilled armure.
Tying-in machine.
Valencia.
Velours.
Velentine.
Velvet.
Vigogne.
Voile.
Warping machine.
Warp-tying machine.
Washing roller.
Waste picker.
Wax thread sewing machine.
Weaving.
Weighting.
Whipper.
Whirling apparatus.
Wool burring machine.
Wool carding machine.
Wool combing machine.
Wool extract.
Wool hat machine.
Wool oiler.
Wool scouring machine.
Wool washing machine.
Worsted.
Yarn flocking machine.
Yarn printing machine.
Yarn reel.
Yarn tester.
Yarn washing rollers.
Yarn winder.

See *Band's "American Cotton Spinner's Guide."*
Leroux's "Practical Treatise on Worsteds and Carded Yarns."

Spin'ning Head. A twisting and drawing head, resembling in some respects that described on p. 2273, Fig. 5408, "*Mech. Dict.*," is described in *Laboulaye's "Dictionnaire des Arts et Manufactures,"* vol. iv., article "*Broche de la Filature,*" edition 1877.

For twisting and drawing heads see the following patents:—

Ballard, 62,921, March 19, 1867.
Chappell, 115,435, May 30, 1871.
Chabot, 89,290, April 27, 1869.
Crowell, 28,161, May 8, 1860.
Germain, 69,205, September 24, 1867.
Goulding, 32,059, April 16, 1861
Hoard, 58,101, September 18, 1866.
Houghtaling, 78,968, June 16, 1868.
House, 99,674, February 8, 1870.
Jenks, 132,582, October 29, 1872.
Kennedy et al., 21,538, September 14, 1858.
Lawrence et al., 108,709, October 25, 1870.
Martin, 177,861, May 23, 1876.
Motting, 128,418, June 25, 1872.
Nutting, 125,686, April 16, 1872.
Parmelee, 56,258, July 10, 1866.
Plummer, 31,031, January 1, 1861.
Potter, 62,498. February 26, 1867.
Roberts, 89,170, April 20, 1869.
Silver, 9,391, November 9, 1852.
Skinner, 135,015, January 21, 1873.
Spineux, 69,944, October 15, 1867.
Sargent, 11,812, October 17, 1854.
Sheffield, 137,033, March 18, 1873.
Victory, 11,106 (hemp), January 13, 1854.
Victory, 28,220, May 8, 1860.
Wilcox, 3,075, May 8, 1843.
Wilson, 37,538, January 27, 1863.
Wright, 5,964, December 12, 1848.

Spin'ning Ma-chine'. The Byewater spinning machine is remarkable as a continuous spinner in contradistinction to the intermittent work of the mule.

The condenser bobbin containing the sliver, as in the mule, is placed upon the top of the machine, and revolving, delivers its contents to and upon the tops of a number of small porcupines, arranged upon a slowly revolving shaft. The porcupines, on receiving the roving, comb and draw the fibers of the wool into parallel lines, delivering it in an attenuated form to another part of the machine, composed of two very small rollers fitted in a disk.

These rollers, one of which is fluted and the other covered with rubber, constitute a pair of draft rollers, as in the ordinary mule, but are so small in size as to serve only for the reception of one thread. The draft motion of these rollers is obtained by the action of a pair of small toothed wheels, that are covered from sight in the disk. From the great amount of twist imparted to the thread in this movement, and in which the proper degree of attenuation is obtained, a much shorter fiber can be spun with less risk of breakages than in the long stretch of the mule.

There has already been spun on this machine a material, the waste of silk noils (that is, the noils of the noils), that has hitherto been used only for upholstery purposes, etc., and which in the mule could not be spun into thread at all. The thread on its delivery from the rollers carried in the disk, is passed on to the spindle, and wound upon tubes in the form of a pin or cone, having received its complemental amount of twine.

Any quantity of twist can be put in between the rollers and the spindle, as the latter can be driven up to 7,000 or 8,000 revolutions per minute. The thread is wound upon the spool by the needle flyer. In order to build a proper cop from the yarn the traverse race differs from that found in roving frames, throstle spinning frames, etc., in having an additional movement. Besides the ordinary ascending and descending movements of the traverse, there is progressive ascent made every journey, equivalent to the growth of the yarn cone from the deposit upon it of every layer of yarn.

See CARDING MACHINE, pp. 167, 168, *supra*.

Spin'ning Ring. In Booth's steel-top spinning rings with steel flanges inserted in the base, the traveler draws perpendicularly, so that when the lower steel flange becomes worn the flange can be reversed and become a perfect ring again.

Fig. 2316.

Potter Spinning Ring.

The Potter ring is another modification of the spinning ring. See Fig. 2316.

Spin'ning Rol'ler. Leigh's anti-friction top roller has two bosses, which are covered with cloth and leather, and made from a solid piece of iron. The bosses are loose running on a dead spindle. There is, therefore, no appreciable wear of either hook-saddle, cap-bar, or roller. Each boss can go its own speed, independently of its fellow boss, and therefore delivers out faithfully its proper length. The leather keeps smooth, saves waste, and the bearings being internal, the roller seldom requires oiling. It saves the squares of the under roller to the extent of the variation of the bosses in diameter.

Spi'ral Au'ger. The American form of auger-bit, raising and delivering its chips on the principle of the Archimedean screw. A modification of the spiral auger is also used in well-boring.

Spi'ral Bat'ter-y. (*Electricity.*) One in which

the elements consist of plates laid together with something to maintain their distance and then rolled together spiral.

Niaudet . . . . . * "*Amer. Trans.*," p. 17.

Spi'ral Con-vey'or. A forwarding device for removing grain to higher levels, when used within a tube or trough in which it works, on the principle of the Archimedean screw.

Fig. 2317.

Spiral Conveyor.

Spi'ral El-lip'-tic Seat'-spring. A spring made of a thin band of steel and wound on a spiral coil, the transverse section of which is elliptical.

Spi'ral Grooved Guide. The spiral grooved guide is a wrought-iron tube, from 8′ to 12′ long, the size of the hole intended to be bored, set with diamonds at intervals, to prevent it from wearing, and provided its full length with spiral grooves, to allow egress for the water and sediment on the way up to the top of the bore-hole.

It is used in boring long holes, and is of especial value in boring for shafts and tunnels; as, by its exactly fitting the hole bored, it prevents the drill from diverging from the direction in which it started, making the hole perfectly straight.

Spi'ral Pump. A pump that raises its water by a spiral flange or screw, on the principle of the Archimedean screw.

Spi'ral Punch. A punch so formed as to cut its way through the metal with a shearing action, which it is alleged does not tend to injure the metal like the ordinary punch.

Spi'ral Seat'-spring. A light spiral spring made of wire for upholstering car-seats.

Spi'ral Spring. A spring made of a metal rod or bar coiled in the form of the thread of a screw, so that it can be compressed or extended in the direction of the axis around which it is coiled.

See —

Compound spiral spring.	Nest spring.
Cluster spring.	Paragon spiral spring.
Dinsmore spiral spring.	Quadruple-coil spiral spring.
Double-coil nest spring.	Round-bar spiral spring.
Edge-rolled spiral spring.	Rubber-center spiral spring.
Equal-bar nest Spring.	Spiral elliptic seat-spring.
Flat-bar spiral spring.	Spiral seat-spring.
Group spring.	Spool-shaped spiral spring.
Half-round-bar spiral spring.	Square-bar spiral spring.
Hibbard spring.	Triple-coil nest spring.
Keg-shaped spiral spring.	Wool-packed spiral spring.

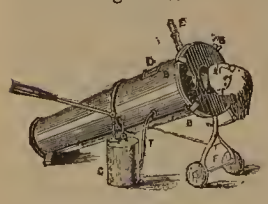
Spi'ral Tube Boil'er. One having a spirally convoluted tube passing across the flame space. See Fig. 5636, Plate LXI, opp. p. 2326, "*Mech. Dict.*"

Spi'ro-phore. A breath-carrier. An apparatus for inflating the lungs in case of suspended animation. *Woillez*, "*Technologiste*," xl. 179.

An apparatus for restoring asphyxiated persons, especially such as have been in danger of drowning, and new-born infants.

It consists of a conical cylinder of sheet-iron closed at one end and open at the other. The case is large enough to receive the body to be treated, which is let down into it as far as the head, that remaining outside. A tightly fitting diaphragm closes the aperture about the neck. A strong air pump containing more than four and a half gallons of air, outside the case, communicates with it by a thick tube. It is worked by a lever, the descent of which produces aspiration of the air confined about the body. The raising of the lever again restores the abstracted air to the case. A transparent piece of glass on the upper part of the cylinder enables one to see the chest and abdomen of the patient, and a movable rod sliding in a vertical tube is made to rest on the sternum.

Fig. 2318.



Spirophore.

When a body is inclosed as described, and the lever quickly lowered, a vacuum is produced around the body and immediately the external air penetrates into the chest, the walls of which are seen to rise as in normal life. The ribs separate, the sternum is pushed up 0.393″ at least (indicated by the movable rod that rests on it). Further, the epigastrium, and even the abdomen below, present an inspiratory projection, which shows that the enlargement of the chest is effected during the artificial inspiration, not only by the raising of the ribs and the sternum but also by the descent of the diaphragm. All returns to the former position when the lever is raised again. These complete respiratory movements may be repeated fifteen to eighteen times in a minute as in a living man.

By means of a tube fixed into the windpipe of the body and communicating with a graduated reservoir of air, over a vessel of water, M. Woillez has measured the quantity of air that thus penetrates into the chest at each pressure of the lever. He finds that this is on an average 1¾ pints; whereas the physiological average is only 7–10 pints. More than 22 gallons of air can be made to traverse the lungs of the asphyxiated person in ten minutes.

Splay. (*Architecture.*) The beveled expansion or recess in the wall of a building, as in the abutments in ancient architecture and the approaches to doors, windows, and fire-places necessarily beveled in the heavy walls of those days.

Splice. (*Nautical.*) The joint by which two ropes are united. · See "*Mech. Dict.*"

Rails and splices on Penn. R. R. See report by *F. Slataper*, "*Centennial Exhibition Reports*," * vol. vi., Group XVIII. p. 66.

Splice Joint. The connecting joints between rails on railways. The number of splice joints per mile, 2 bars and 4 bolts and nuts to each joint, is, rails 20′ long, 528 joints; rails 24′ long, 440 joints; rails 26′ long, 406 joints; rails 28′ long, 378 joints; rails 30′ long, 352 joints.

Spli'cing Clamp. A hinged clamp with apertures of various diameters to correspond with size of the material intended attached.

Splin'ing Ma-chine'. (*Metal Working.*) A machine for cutting key-seats and grooves.

Splint.

Wood's hammock splint.*

Ahl's adaptable porous splints.

See *Dr. J. H Thompson's* report on Group XXIV. in vol. vii., page 58, "*Centennial Exhibition Reports.*"

Guillery, Hippolyte, Brussels, Belgium.

Perforated zinc plates adapted in shape to the fractured limb.

See also "*Scientific American Sup.*," 788.

Cable, *Stillman* . . . * "*Scientific American Sup.*," 1597.
Paraffin, *Macewen*, Engl. "*Scientific American Sup.*," 2310.
Fracture, *Croskery* . . * "*Scientific American Sup.*," 873.
Split pulley . . . . . * "*Engineer*," xlix. 71.
Plaster of Paris, paper by
Croft . . . . . "*Scientific American Sup.*," 2121.

Splint-cut'ting Ma-chine'. A machine for cutting small slats or splints.

Ransome, of Chelsea, England, has a reciprocating cutting machine for lucifer-match splints, etc.

Split'ting. (*Leather.*) Reducing the sides of leather to a uniform thickness, by passing them through the splitting-machine. The latter can be adjusted to split the sides to any required thickness. It is mainly employed in the preparation of thin and light leathers.

Split'ting Chis'el. (*Stone-working.*) A tool chiefly used on the softer stratified stones, and sometimes on fine architectural carvings in granite.

Split'ting For'ceps. (*Dental.*) For the division of teeth which require to be split before extraction.

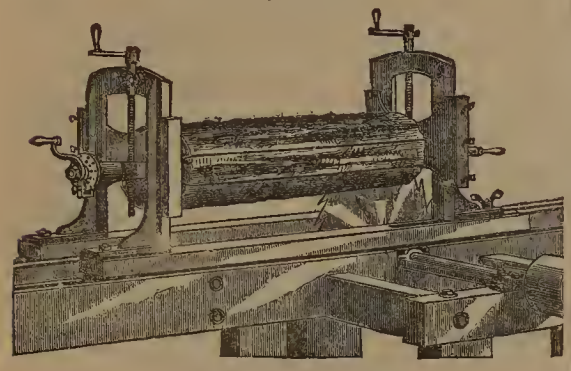
Split'ting Knife. (*Fishing.*) For ripping and halving fish before salting.

Split'ting Ma-chine'. A machine for resawing thick boards.

Split'ting Saw. A saw table with elevating set serew, adjustable elamps, splittiug gage, aud self-oiling saw arbors.

A machine for splitting round logs into bolts; as a substitute for riving or sawing through and through iu parallel

Fig. 2319.



Splitting Saw.

planes. The center sawing machine is used in getting out stuff for axe and pick handles, heavy spokes, etc., and work in which the run of the grain of the wood is of consideration in the fashioning of the article. It has a slidiug carriage, furnished with eenter head-blocks, on whieh the log is plaeed, and is provided with a dial-plate and stops by whieh the log ean be spaced into stuff of the desired size. The saw euts invariably towards the center. Also called a *center saw.*

Split Wheel. A split gear or otber wheel so contrived that flanges on the one side of the one part fit upon and are bolted to the side of the other part, to allow of applying to and removing from the shaft sueh wheels in less space than is rcquired when they are fastened by bolting two flanges together at the sides of the wheel. One part of the wheel may also be dovetailed into the other, to sustain the expanding action of the key, better than in the other way.

Spoke. (*Wheelwright.*) One of the radial arms that conneet the hub with rim of the wheel.

Spoke-in-sert'ing Ma-chine'. A spoke-setting machine, for inserting the spokes by mechanical pressure instead of driving.

Spoke-fa'cing and True'ing Ma-chine'. (*Wheelwrighting.*) A machiue designed for faciug common and patent spokes, and finishing the miter joint on them.

It has a large cast-iron disk, in which are plaeed three cutting knives. The disk is revolved, and the spoke, being plaeed in position on the table, is brought into contact with the eutters, finishing it to the desired surface or angle. The table is light and moved on parallel ways, plaeed at right angles to the face of the disk, aud has a spring that returns it from the disk when the eut is completed. It is furnished with necessary stops and guides.

The pulley or disk-shaft, 10 × 5, should make 1440 revolutions.

Spoke Lathe. A machiue for turning spokes, gun-stocks, lasts, handles, etc.

Spoke Point'er. A knife held in a cone devised to dress up the tenons of the spoke ready for hub and rim. (See Fig. 2320.)

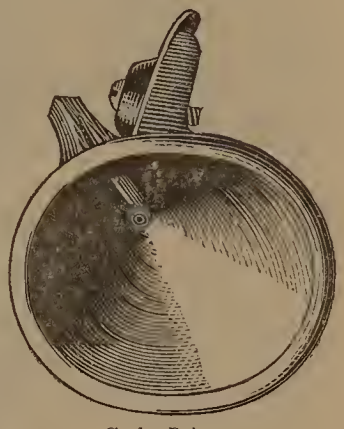
Spoke Pol'ish-ing Ma-chine'. Gleason's spoke polishing machine takes a saud-belt from 6″ to 12″ wide. Its driving pulleys, tight and loose, are 7″ diameter, with 5″ face. It makes 900 to 1,000 turns per minute.

Spoke Set'ting Ma-chine'. Morgan's spoke setting machine has an adjustable frame that is supported on springs so as to be moved vertieally as desired by the bolts and crank-nuts. The hub is placed on a central bolt, and is rigidly secured by a crank-nut.

Above the main frame is the guide or set ring on which the posts are plaeed while being set and driven into the hub.

After the hub is fasteued in plaee, the adjustable frame is screwed dowu until the ceuter line of the hub is on a level with the circle. The hub is then dotted above the leveling straight-edge, and the bolts are screwed down until the desired dish or set of the bolts is obtained. This is necessary, as all hubs are made with straight front and sloping back mortises, throwiug the outer ends of the spokes forward at the same inclination. It then only remains to rest the spokes upon the guide-ring and drive them iuto the hub.

Fig. 2320.



Spoke Pointer.

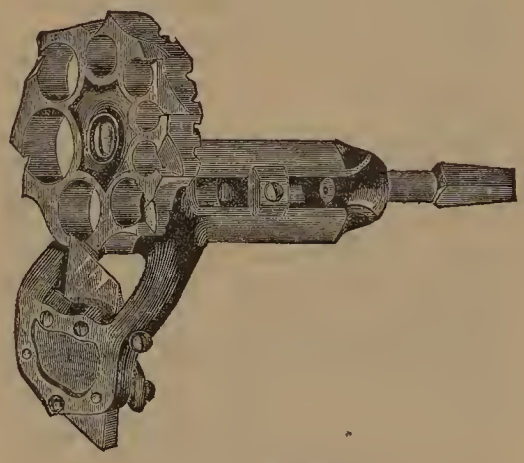
Spoke settiug machine, *Morgan* . * "*Sc. Amer.*," xxxiv. 343.

Spoke Shave. A modifieation of the plane with a handle at each end. The Freueh make a double spoke-shave, with one blade coucave, the other convex.

Spoke Ten'on-ing Ma-chine'. A machine provided with a hollow auger, that, rotating around the ends of the spokes, forms the tenons.

In Dole and Deming's spoke tenoning machine, Fig. 2321, the hub is held in a self-centering chuck that admits of rotating the wheel to present the spokes to the hollow auger, the spokes when in position being firmly held on the spoke rest, iu line with the auger. Each and every tenon is eut

Fig. 2321.



Spoke Tenoning Auger

with shoulders uniform in width and in the same plane. With a slight transformation it is changed into a boring machine, for boring the felloes for the spokes and dowel pins. The No. 1 machine is provided with the star hollow auger, capable of cutting tenons from 7-16″ up to 1″. The No. 1 machine is not furnished with legs, being generally clamped in the vise or on the bench.

Spoke Throat'ing Ma-chine'. A machine intended for dressing and shaping the throat (which is redueed a short distance from the hub to add to its flexibility).

Spoke Turn'ing Lathe. Gleason's spoke turning lathe is a modification of the Blanchard. ("*Mech. Dict.*," p. 2282.) It is used for turuing handles as well as spokes.

The uprights forming part of the rocking frame are fastened to the rock shaft by set screws. The adjustable upright is movable on the shaft with wrought iron cross bars above, to take in any desired length of model. The center for holding the model in the said upright and the center for holding the spoke admit of being adjusted to any position, so as to turn spokes from the same model of different lengths.

The center is worked by an eccentric lever and is capable of holding the largest spokes. The running shaft extends outside to the left of the machine, and pulleys for driving the model and feed run loosely thereon. The pulley that drives the cutting wheel above has a hollow mandril, running in bearings one on each side. The hollow mandril is fitted with two feathers which fit into slots that run the whole length of the main shaft. The bearings are part of the carriage, that exteuds down on the opposite side to receive the hollow mandril carrying the pulley that drives the cutter wheel.

Spoke Trim'mer. A tool for trimming the ends of spokes, chair rounds, etc., before using the hollow auger.

Spoke Wheel. A metallic light flanged track wheel for mine cars and other light service.

Sponge Brush. Sponge brushes are of various kinds, in which the sponge tied or wired to a handle is a substitute for bristles.

Sponge Di-la'tor. (*Surgical.*) A dilator in which the absorptive power of sponge is made the means of expansion. *Emmett's*, Fig. 110, Part V., *Tiemann's "Armamentarium."*

Sponge For'ceps. (*Surgical.*) An instrument specially adapted to hold a sponge, and place it in situ. It is usually a long staff with a spring or sliding clasp on the end. Page 81, Part III., *Tiemann's "Armamentarium."*

Sponge, Me-tal'lic. M. Laboulaye treats of the "industry created" by M. Chenot, which, at the time of writing, had not "arrived at a complete success, for the full adoption of the process would completely revolutionize the metallurgic industry; but the results obtained (1877) were extremely important."

For the study of the process he selects the most complex to which the method can be applied, that of the production of cast steel.

The treatment comprises four principal operations: —

1. The reduction of the mineral into the state of sponge.
2. The cementation of the sponge.
3. The compression.
4. The fusion.

1. The reduction takes place on wasted and broken mineral, in a prismatic furnace about 40′ high, furnished with exterior belt of furnace from the mouth 22′ downward. The mineral introduced at the top is subjected to a gradually increasing heat, undergoing a reduction similar to what takes place in the shaft of the blast-furnace. On arrival at the bottom of the belt furnace it is scarcely cherry-red, the iron is completely reduced, but the heat is insufficient to melt it, or even to make it pasty. It forms a porous mass like the spongy platinum whence it takes its name.

Continuing its descent, the sponge cools slowly, and at its discharge at the lower end of the furnace is near the ordinary temperature, in default of which cooling it would rapidly reoxidize, owing to its eminently pyrophone tendency. The discharge from the furnace is made at certain intervals by means of certain devices whose function is to prevent a current of air from passing through the furnace.

2. The sponge, passing to the cementation stage, is plunged in a bath of resin, tar, or some fatty matter, the bath being heated if necessary to maintain its contents liquid, in order that the sponge may be saturated. It is calcined at a heat only sufficient to remove excess of the carbonaceous matter which is collected, and a loup of metal is obtained with a certain quantity of carbon uniformly diffused through it. A second cementation may be necessary to arrive at exact results.

3. The sponge is then broken and afterwards subjected to heavy pressure in order to make it more compact and to reduce the surface exposed to the action of the oxygen of the air.

4. The compacted sponge is broken up, put into crucibles, and treated as usual for cast steel. There is, however, this difference, that in pouring the metal there is a quantity of scoriæ consisting of earthy matter which the previous operations have not removed. The slag, which is very fluid, swims on the metal, is coagulated by a little sand and clay, and readily removed with a ladle.

Blair's process is described in, —

"*Scientific American Sup.*"	1991, 1992.
"*Scientific American*"	xxxix 68.
"*Mining & Scientific Press*"	xxxvii. 2.
"*Engineer*"	xlv. 226, 308.

The United States and European patents on sponge processes are very numerous.

Sponge Pro'cess. (*Metallurgy.*) A process for making wrought iron and steel direct from the ore without the use of the blast furnace.

The reduction by the blomary or German hearth is at a greater heat than that of the sponge process. The temperature in each is below that of melting; in the blomary the iron is obtained in an agglutinated mass, as a *loup* ready for the shingler; but the *sponge* obtained by the other process contains the iron in a metallic state besides the earthy ingredients of the ore. The *sponge* is then worked to a *loup* in a reverberatory, gas, or blomary furnace, to consolidate the metal and remove the earthy matter, and then is hammered to a *bloom*.

The reduction of the ore in the sponge process takes place in a cylinder or cupola furnace, the fuel with which it is mixed being preferably charcoal. The iron is cooled before removal from the reducing current, to prevent oxidation, which takes place rapidly on the spongy mass.

The sponge is then puddled in a reverberatory.

Or it has been added to a bath of pig-iron, as wrought iron is added in the Martin process to make steel by relatively lowering the carbon of the iron.

Chenot, Yates, Benton, Gurlt, and others have devised sponge processes. The method adopted by Blair, of Pittsburg, is a modification of the Chenot.

A cylinder 40′ high and 36″ diameter has at 6′ of its upper end an interior cylinder 28″ diameter, leaving an annular space 4″ wide. The upper half of the cylinder is kept at a red heat by gas burning on the outside, and the charcoal and ore in small pieces are charged at the upper end of the annular space. The carbonic oxide from the reduction burns in the inside cylinder, and the charger is then heated to redness between the two fires. As the charge sinks it occupies the whole interior capacity of the large cylinder, the lower half of which is cooled by a water-jacket. The sponge and remaining portion of the fuel are withdrawn in a cool condition from the lower point of the cylinder.

The sponge is separated from the charcoal, compacted into balls by hydraulic pressure, which are then worked into a bath of metal in a Siemens or other furnace.

Sponge is also made in a Danks rotary puddling furnace; the ore is roasted, added with fuel to the furnace, which is rotated while a reducing flame on the regenerative principle is applied.

In 1876 Blair discovered during some experiments, that by the addition of a small quantity of alkali to the carbonaceous matter mixed with the ore, the action of reduction was quickened to a remarkable extent, and ore which took thirty hours to reduce without alkali could be perfectly done in six hours with it. Subsequent investigation showed that lime in a fallen state answered as well as any other alkali, and on account of its cheapness was most suitable for the purpose. The quantity of lime required being only about five per cent. the extra cost was quite insignificant when placed against the great saving in time. When, however, Mr. Blair came to work the existing furnaces under the new condition of quickened reduction, he found the arrangement could not in any way be altered to suit it. Perhaps a brief description of these furnaces will make the matter more easily understood.

Each reducing furnace consisted of a group of three vertical retorts, each retort being 3′ internal diameter and about 28′ high, surrounded by an outer casing of brickwork, leaving a combustion chamber between the inside of the brickwork and the outside of the retorts. The retorts and outside brickwork stood upon a cast-iron entablature, supported on columns 12′ from the ground; below the entablature, and forming a continuation of each retort, were wrought-iron cylinders, each surrounded with a water jacket for more quickly cooling the iron sponge, and having at the lower extremity a sliding sleeve for discharging it. In the top of each retort a cast-iron pipe or thimble, 2′ diameter and about 6′ long, was inserted, leaving an annulus of 6″ between it and the inside of the retort.

The retorts were heated externally by gas jets, the air for combustion being supplied through apertures immediately above each jet. When the retorts were thoroughly heated and all in working order, the gas generated from the ore under reduction ascended up the inside of the pipe inserted in the top of the retort, and, on meeting with the air, flamed and so heated the pipe. The ore and carbonaceous matter were fed into the retort down the 6″ annulus between the retort and pipe, and, forming a narrow column heated on both sides, were thoroughly heated up before reaching the wide retort below. Thus the ore, on entering the wide retort or reducing zone, was all of one uniform heat, both in the center and

on the outside, and hence uniform reduction was the result. This initial heating, as it is called, must be done if the ore is to be thoroughly and uniformly reduced. It was this part of the furnaces which would not suit the quickened action of reduction taking place in the body of the retort below; the ore could not be heated up as quickly as the reduction took place, and hence the two did not work in harmony.

After several alterations, Mr. Blair abandoned the system of external heating, and decided to adopt that of passing a stream of hot carbonic oxide through the mass of ore and carbonaceous matter. He has since made some improvements in the first-named furnace, where the initial heating of the ore is performed as quickly as is possible to be done by transmitted heat, and which is much quicker than the inserted pipe. The new form of reducing furnace adopted by Mr. Blair has several important features. The following is a description of it: —

A vertical retort made of fire-bricks, with an external wrought-iron casing, stands upon a cast-iron entablature supported on columns. The retort is continued below the entablature by a wrought-iron cylinder with water jacket, or as the writer proposes, instead of one wrought-iron cylinder and water jacket, four small ones are suspended, and thus split up the hot sponge into small columns, by this means effecting the cooling much more quickly. At the lower extremity of each water jacket is a conical mouthpiece and valve, so that the iron sponge can be discharged periodically into any receptacle placed under.

The lower part of the retort, where the gas is admitted, is larger than the upper portion. This is done so as to form an overhang immediately above the aperture where the gas is admitted, thus forming a chamber round the mass of ore, etc., and allowing the gas to permeate it uniformly. At the top of the retort is an outlet for the escape of the gas after passing through the ore, which is connected by a horizontal pipe to a vertical one descending to the ground, and there connected to the chimney flue. In the horizontal pipe above named a steam jet is inserted, so as to form a vacuum in the top part of the retort, to induce a regular current of gas through the ore, etc. The retort is fed by an ordinary bell-hopper.

The carbonic oxide is generated in a gas-producer placed a few feet from the reducing furnace, and connected to it by a flue of sufficient capacity. The gas-producer is circular in section, formed of wrought-iron plates, lined internally with fire-bricks, and standing on an entablature, which, in turn, is supported at the requisite height by columns of brickwork. Below the entablature, and suspended from it, is a wrought-iron continuation, tapering to a conical discharging valve for allowing the ashes to be from time to time removed.

Apertures for admitting air for combustion in the gas-producer are placed in its circumference, fitted with slide covers to regulate the admission of air.

Mr. Blair uses the Ponsard producer in preference to the ordinary Siemens one, as the admission of air is more easily regulated. The object of using a carbonic oxide gas is primarily to supply heat to the ore, etc., to be reduced. What reduction is effected by the gas is a secondary matter; and in this point the process differs from other attempts where carbonic oxide has been used solely for reducing the ore. It will be seen that in using the steam jet to induce a stronger current of gas through the ore under reduction, the temperature in the gas producer will be increased, and the gas in time become hotter than required, the result being that the mass against which the gas impinges in the reducing furnace, being almost entirely metallic, would become welded together, and so interfere with the regular working of the furnace. To obviate this, a very simple and ingenious arrangement has been made by Mr. Blair, by which the temperature of the gas can be kept at almost one uniform heat. The gas, after passing through the reducing furnace, is still almost entirely carbonic oxide, and on passing by the steam jet becomes mixed with steam; in order to condense it a water spray is introduced at the top of the descending flue to the chimney. A little above the air apertures in the gas producer are two pipes connecting it and the descending flue, so that some of the gas which has already passed through the reducing furnace can be again sent through the gas producer and used over-again, and at the same time cool down its temperature. By regulating the slide covers of the air apertures in the gas-producer and the damper in the flue to the chimney, an equal quantity of air and gas can be supplied to the producer. It is found, in practice, the two can be so regulated that an almost uniform temperature can be maintained in the reducing furnace, and a saving effected in fuel; in fact, by the cooling action of the return gas, any temperature can be obtained. The reducing furnace just described will reduce about 200 tons of ore to a metallic state weekly, the dimensions of the retort being 5′ diameter in the upper, and 6′ 6″ in the lower part, by 16′ in height. The height of the whole structure is 36′, and the cost about $3,500.

The fuel used in the gas-producer is coke; and if the iron sponge made is intended for steel-making, the coke should not contain more than .75 of sulphur — the less the better — otherwise the iron sponge will be affected by it. But where pure ore can be had, and coke from washed coal not containing more than the above-named amount of sulphur, this form of reducing furnace is undoubtedly the best for producing iron sponge in large quantities, and the whole of it thoroughly metallic.

The question of the subsequent use of iron sponge is an important one. Where the ore is rich and pure, iron sponge made from it can be at once made into tool steel, the quality of which cannot be equaled by that made from the best brands of Swedish bars. Probably in the case of ore which is not so rich, but still suitable for steel-making, the best way of utilizing the sponge made from it is to melt it in a cupola furnace into pig metal, and while in a molten state pour it into a Siemens-Martin furnace, and in this way convert it into steel. The pig metal obtained in this manner will contain about 1.5 carbon and practically no silicon, the greatest amount of the latter yet found by analysis being 0.25, and the lowest 0 19. If this metal is poured while molten into an open hearth furnace as proposed, there ought to be no serious difficulty in getting six heats from each furnace in twenty-four hours, in place of the two or three heats now obtained. Iron sponge melts readily in a cupola furnace, and the risk of oxidation is less than when it is thrown into a bath of pig iron in an open hearth furnace. The same remarks apply to the manufacture of wrought iron. From the nature of the particles of iron in iron sponge, being so minute, it cannot be balled up in an ordinary balling furnace without considerable oxidation; on the other hand, if melted in a cupola furnace, and the resulting metal, containing so little carbon and silicon, be taken in a molten state from the cupola to the puddling furnace, very little rabbling brings it to nature.

The molten metal can be made almost as cheaply as pig iron; in fact, there is no reason why it should not be made as cheaply.

Sponge Pla-ti'num. The production of spongy platinum, says the "*Metallarbeiter*," is a task more easy in appearance than in reality. The principal requirement of spongy platinum is that it should be spongy, but this obvious requirement is very frequently overlooked, and hard and useless masses of platinum are produced through overheating the sponge and running together the finer particles. Into a concentrated solution of muriate of ammonia drop a similar solution of platinum chloride; a yellow precipitate is formed, which is washed three or four times with hot water to free it from the sal ammoniac. This precipitate, when properly cleaned, and while still moist, is dropped on a very thin platinum wire stretched several times across a small ring of copper, and is then allowed to dry thoroughly. After drying, it is slightly heated over a spirit lamp, contact with the flame of which is to be avoided. As above remarked, only very careful heating over the spirit lamp will give satisfactory results.

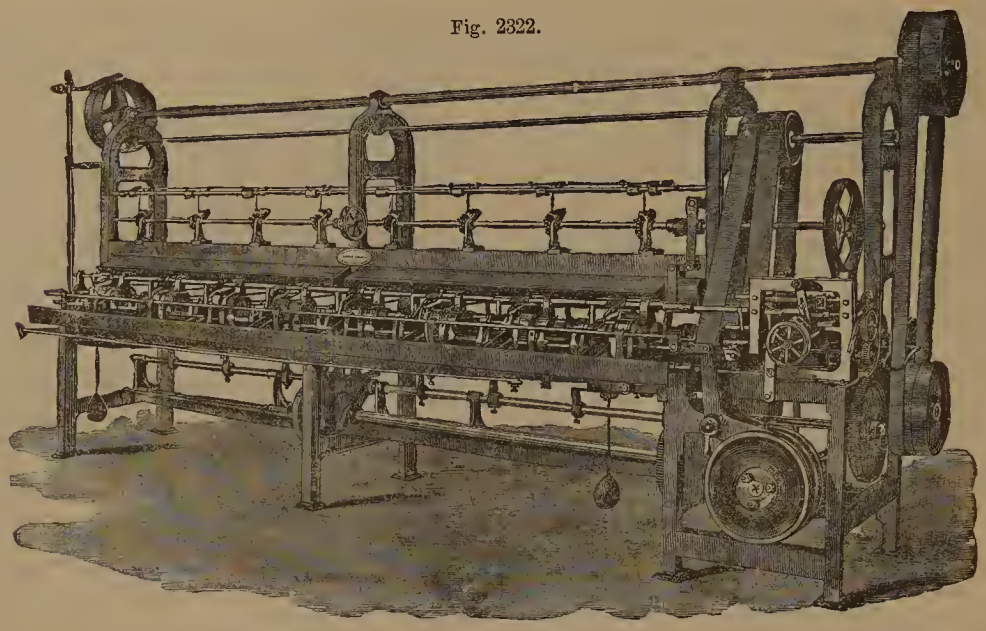
Sponge process, *Blair* . "*Iron Age*," xxi., April 11, p. 16.
"*Scientific American Sup.*," 1991.

Spool Hold'er. A case for holding spools of different numbers of thread placed on the thread-holder of a sewing machine. The spools are placed on pivots and the case revolves so that any spool can be drawn from at will.

Spool'ing Ma-chine'. A machine for winding silk on to 100, 200 yards, or one-ounce spools, for domestic and manufacturing purposes. See also Silk Spooling Machine.

Fig. 2322 gives a front view of a spooling machine composed of two parts, the portion on the left consisting of eight little duplicate machines arranged in a row, and that on the right, of the apparatus which operates the winding machines. Each of these little machines winds a spool of thread. Back of these is a trough, containing empty spools, and back of this is a shelf which is intended to hold the bobbins of thread. From these bobbins threads are passed through a tension apparatus above them, and carried each to its little machine. The machines are held rigidly together by longitudinal rods, and there are three longitudinal shafts or rods passing through the whole set from the machinery at the right-hand end; the upper one, which we will call the guide-rod, moving back and forth and giving side motion to the thread; the main shaft below and behind, with cog-wheel attachments at each machine for revolving the spools; and a rod in front which carries a steel finger for

Fig. 2322.



Spooling Machine.

moving the thread, as will be explained presently. The spools are held horizontally and longitudinally in position just back of the front finger-rod by clamping-pins like axles, which pass into the holes at the ends and revolve with the spools very rapidly. Just back of each spool is a swinging curved hopper, its upper end reaching almost to the spool-trough previously mentioned, and its lower end open and curving up just under the position of the revolving spool. All that the attendant has to do is to keep the hoppers filled with empty spools, remove the full spools from the lower troughs as they accumulate, and see that the thread is regularly supplied by the bobbins behind.

A thread-guide is fastened on the upper sliding or guide-rod at each machine. The thread passes down from the tension apparatus over this guide to the spool. As the spool revolves, the longitudinal motion of the guide-rod back and forth moves the thread to and fro over the spool, which winds it up layer by layer.

A measuring-gage is attached to the machine, and just as two hundred yards are wound, the spool ceases to revolve; a little chisel moves up and nicks its edge; the sliding-rod in front with its steel finger moves longitudinally and draws the thread over; a hook passes up and pulls it down tightly into the nick; another chisel cuts it off, and the spool drops down into the receptacle provided for it in front. The swinging hopper then flies up with an empty spool in its curved lower end, which is taken up by the axle-clamp and starts into revolution. At the same time the thread, the cut end of which has been held down by the apparatus for the purpose, is pulled over and started on the new spool, and the operation proceeds as before.

The part of a spool on which the thread is wound always has a variable length, increasing as the winding proceeds outward from the center. Provision must therefore be made to give this variable motion to the guide-rod carrying the thread-guides. This is effected in its feed at the right end by giving a variable motion to the stops changing its direction There are attached to this guide-rod two segmental nuts which are made to come alternately into contact with a revolving shaft having reverse screws contiguous to each other, one screw working in each half nut, causing the nuts to travel first in one direction and then in the other. These nuts connect with an arm with a forked end, which works on a fulcrum and operates over a pair of stops or jaws, pressing on to them and moving above them for one motion, and below them for the other, two heavy springs operating to produce the pressure and change the motion, alternately forcing it down and up, the alternate action of the nuts changing each time in accordance with this motion. By means of a cam and an arrangement of toggle-joint the pair of jaws opens gradually as the thread winds, keeping at a certain distance to correspond to each particular layer, thereby regulating exactly the sliding movement of the guide rod. When the winding is finished and ready for another spool, the jaws are suddenly closed to their smallest dimensions and the operation is repeated.

Spool cotton works.
Willimantic . . . . * "*Scientific American*," xli. 351.
Spooling machine, cotton.
Cobb . . . . . * "*Scientific American*," xxxix. 98.

Spool Print'ing Ma-chine'.

The spools are agitated by reciprocating rods, and guided through a conduit into a race, from which the forward one is discharged by a flexibly-driven plunger into one of duplicate receivers, in which it is held by a reciprocating holder. During this movement the duplicate printing-dies, having been inked while at rest, move forward, are tipped into horizontal position by cams, and, moving against the spool, print its opposite ends in different colors, and, retreating, are raised into vertical position to be inked, while the rear spool-holder, rising, liberates its spool, and the receiver, making half a revolution, discharges the rear spool by its contact with a discharge arm, and moves into position to receive another spool, when the former operation is repeated, and the printed spool carried to the rear and the new one received are again printed, the former receiving a new impression in a contrasting color.

Spool'-shaped Spi'ral Spring. One narrower at the waist than at the ends. The opposite of *keg-shaped*.

Spoon. (*Surgical.*) See CURETTE; SCOOP.

(*Fishing.*) An object of glass, metal, mother of pearl, bone, or what-not, armed with a hook and towed abaft a boat, so as to shine while in motion and resemble a small fish. Trawling or trolling.

Spray Con-den'ser. (*Steam.*) The condenser, Fig. 2323, consists of two chambers, one over the other; the exhaust steam from the engine is admitted to the upper chamber, and is there condensed by contact with the injection water, which is brought in at the top, and made to fall on a perforated plate, which produces a rain-like spray. The condensed steam and injection water is drained away by alternately creating and destroying a vacuum in the lower chamber. This is accomplished by first opening a valve, and admitting a small quantity of steam at a very low pressure (1 or 2 lbs. per square inch), and then opening a valve to admit cold water; these two valves are actuated by tappets geared up to a shaft to produce seven strokes per minute. A steady vacuum of about 28″ is obtained with about half the water used in the ordinary jet condenser, and the condenser will draw its own water from any depth up to 27′. Salt, muddy, or even sandy water may be used, if pure water cannot be obtained.

Spray'ing Ma-chine'. A machine invented by Daughtry to irrigate growing cotton plants with wet poison to destroy the cotton caterpillar.

See *Comstock's* "*Report upon Cotton Insects*," 1879, p. 242.

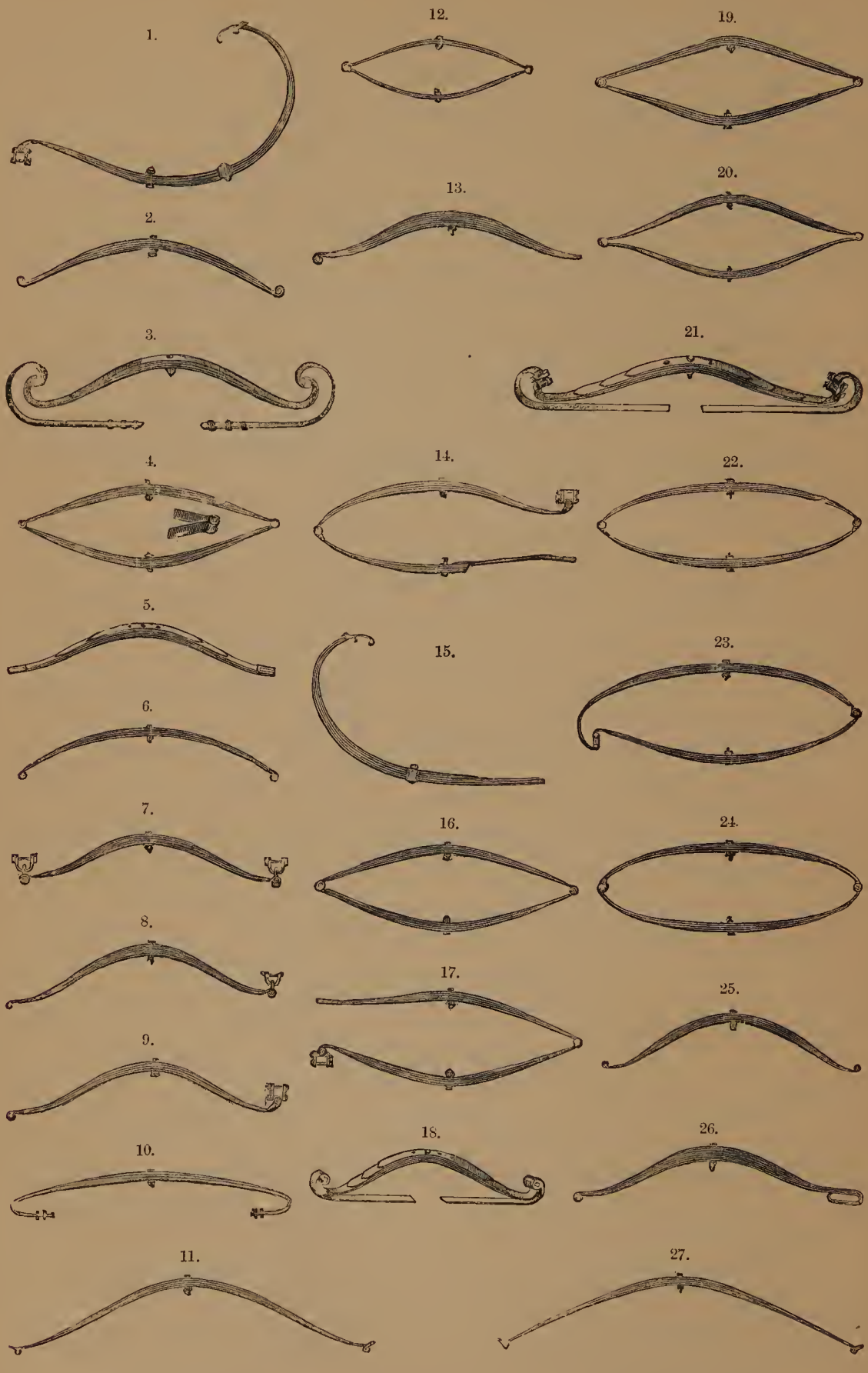

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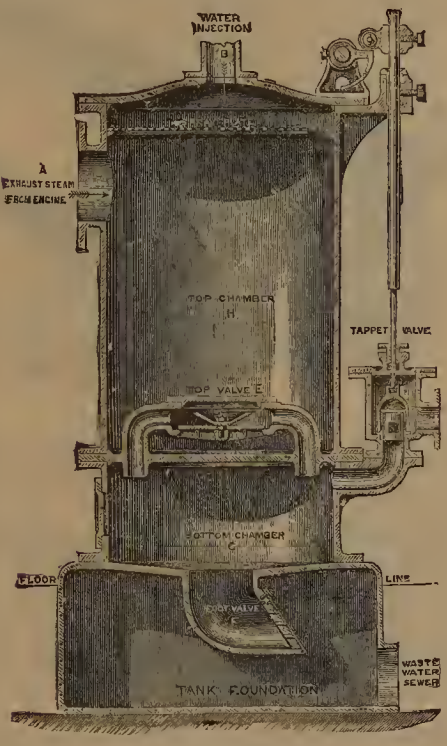
Fig. 2323.

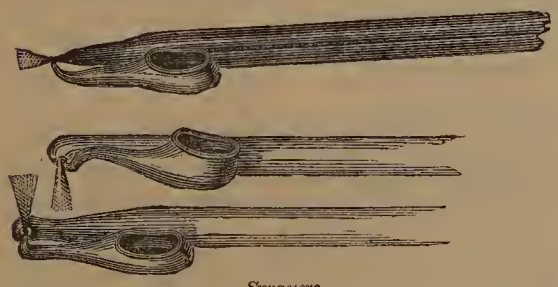


Spray Condenser.

Willie's atomizer, *Ibid.*, * p. 243.
Johnson's sprayer, *Ibid.*, * p. 245.
See also SPRINKLER; FOUNTAIN PUMP.

Spray In'stru-ment. The set of atomizers represented in the cut are arranged for spraying

Fig. 2324.



Sprayers.

the throat. The set consists of three straight tubes of strong glass, seven inches in length, tapering at the distal end to a point with only a small perforation. On the right side of this extremity a second little funnel-like tube is strongly cemented. This is for holding the few drops of the medicament to be used, and may be filled from the bottle or with a pipette.

In one instrument the point of the medicine-tube is exactly in front of the air-tube; this is for throwing the spray directly into the throat. In the other two a variation in the direction of the tube gives a correspouding direction to the spray, so that it may be thrown upward with one instrument and downward with the other.

A common Davidson syringe or rubber air-bulb may be attached to the proximal end of the long tube for forcing the air through.

Both tubes, for an inch from the distal end, are flattened on their under surface, and roughened, and serve the purpose of a tongue-depressor.

Spray Noz'zle. For spraying a stream instead of delivering it solid.

The nozzle shown in Fig. 2325 enables the pipeman to approach and enter a burning building; and with it the excessive use of water, and unnecessary damage to goods, may be avoided. It consists substantially of a common nozzle, having a number of small levers pivoted aronnd it near the outer end. These levers extend about 2″ beyond the end of the nozzle, and are inclosed in a neat cup or guard, *A*, completely protecting them from injury. They are bent inwards at a slightly acute angle, resembling the figure 7. The part corresponding to the short leg of the figure is wedge-shape, the thin edge being nearest the aperture of the nozzle. The other ends of these levers (below which they are pivoted) are connected with the collar, *C*, in such a manner that when the collar is revolved one-eighth of a revolution to the right, the wedge-shaped parts of half the levers are projected into the stream, dividing it up into a number of triangular streams. By turning the collar *C*, one-eighth of a revolution further, the remaining four levers are projected into the stream, dividing it up into double the number of streams. These streams, after leaving the nozzle a few feet, become a dense mass of flying spray, covering a large surface, and extinguishing the fire with wonderful rapidity.

Fig. 2325.

Spray Nozzle.

The illustration shows very clearly the solid stream, half spread, and full spread. Any intermediate degree of spread can be given to the stream, according as the pipeman is near to or remote from the fire.

Spread'er. An attachment to the end of a branch-pipe to make it discharge a sheet instead of a jet or solid stream.

Spring. Plate XLV. gives a variety of vehicle springs.

1. C spring.
2. Dray spring.
3. Half scroll spring, button head.
4. Berlin head elliptic.
5. Bolster spring.
6. True sweep side spring.
7. Platform cross spring.
8. Scroll head side spring, hole out of center.
9. Scroll head cross spring, hole in center.
10. Spar spring.
11. Double sweep Concord spring.
12. Seat spring.
13. Straight-end truck spring.
14. Coach platform spring.
15. Cradle spring.
16. Full elliptic button head.
17. Coach platform spring.
18. Half scroll spring, button head.
19. Philadelphia elliptic button head.
20. Yankee-end elliptic.
21. Half scroll spring, with loops.
22. Full elliptic.
23. Full scroll spring.
24. French elliptic French head.
25. Coach platform cross spring.
26. Loop-end truck spring.
27. Single sweep Concord spring.

See under the following heads: —

Back-lash spring.
Back spring.
Bolster spring.
Bow spring.
Buggy spring.
Carriage spring.
Car-seat spring.
Car spring.
Combination spring.
Compound spring.
Cluster spring.
C-spring.
Door spring.
Double-coil spring.
Draw spring.
Edge-rolled spring.
Elliptic spring.
Equal-bar nest spring.
Flat bar spiral spring.
Graduated spring.
Group spring.
Gum spring.

Half elliptic spring.
Half-round-bar spiral spring.
Half spring.
Hibbard spring.
India-rubber spring.
Journal spring.
Keg-shaped spiral spring.
Multicoil spring.
Nest spring.
Platform spring.
Quadruple coil spring.
Quadruplet.
Quintuplet.
Round-bar spiral spring.
Rubber center spiral spring.
Rubber center spring.
Rubber spring.
Seat spring.
Shank spring.
Single-coil spring.
Spiral spring.
Spool-shaped spiral spring.
Spring band.
Spring beam.
Spring block.
Spring cap.
Spring case.
Spring hanger.
Spring plank.
Spring saddle.
Spring seat.
Spring shelf.
Spring stud.
Square-bar spiral spring.
Thorough-brace spring.
Triple coil spring.
Triplet.
Triplet spring.
Vehicle spring.
Volute spring.
Wool-packed spiral spring.

Spring testing, *de Bonneville* . . . . . * "*Van Nostr. Mag.*," xviii. 519.
Springs, uses and Manuf. *de Bonneville* . . . * "*Van Nostrand's Mag.*," xviii. 391, 523.
Spring motors . . . . * "*Scientific American Sup.*," 723.
Spring motor . . . . "*Scientific American Sup.*," 791.
Shoemaker. *Maeslein.*
Frahm et al. *Howell.*
Doubler. *Lathrop.*
Bacon.
Spring motors for sewing machines . . . . . * "*Scientific American Sup.*," 2256.
Spring motors (2) . . * "*Scientific American Sup.*," 757.
Schumacher. *Jones.*

Spring Band. (*Vehicles.*) An iron strap which clasps the plates of an elliptic spring.

Spring Bar Clip. A clip for fastening the spring-bar to the spring.

Spring Beam. A transverse timber which rests on top of the body-springs of a six-wheeled car-truck. There are two such beams to each truck, on which the bolster-bridges which support the bolster rest. — *Forney.*

Spring Block. 1. A seat secured to the axle to give a larger longitudinal support to the spring. 2. A distance-piece used in some forms of springs.

Spring Buf'fer. A spring device to receive the shock between colliding or impinging objects.

Spring Cap. A socket against which the top of a spring works.

Spring Case. A box inclosing a spring, as in some forms of car-springs shown on pp. 482, 483, "*Mech. Dict.*"

Spring Catch. A Y-shaped spring-piece, the bifurcated parts having their ends turned outward and back, used in raising pipe from drive wells.

Spring Com-pres'sor. (*Optics.*) A means for compressing or squeezing an object whilst under examination with the microscope. The glasses under which it is placed are pushed together by a spring and kept apart by a screw. It is made of convenient size for lying on the stage of a microscope.

Spring Coup'lings. The shackle joining the transverse and lateral springs in side-bar and platform springs in buggies.

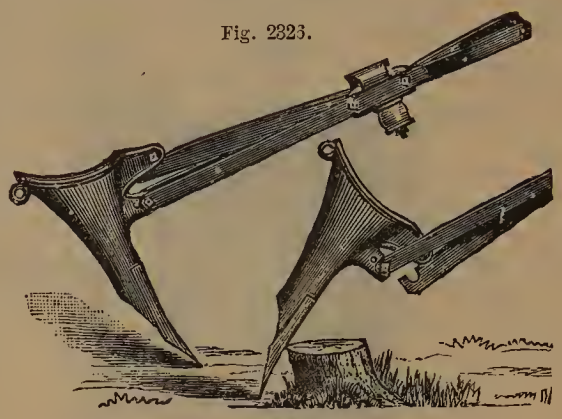
Spring Hang'er. A loop or clevis which sustains a spring beneath an object.

Spring Hinge. One in which a spring automatically closes the door when opened.

Spring Hoe. In the Farmer's Friend Drill, shown in Fig. 2326, the hoe is attached to the drill in the usual way, but is arranged so that the fastening forms a hinge, and when the hoe strikes any fixed obstruction it flies back and passes over it, when the expansion of a rubber spring that is compressed in the operation brings it back to its proper position.

Spring Hook. (*Fishing.*) A supplementary hook, which, when a fish catches the barbed hook, springing down, secures the fish from getting free.

Fig. 2323.



Spring Hoe.

See Fig. 2000, p. 872, "*Mech. Dict.*"; and for list of U. S. Patents, see p. 275, "*Report U. S. Fish Commission*," Part I., 1873.

Spring Net. One closed by trigger and spring. Used in catching birds. A flap net. Another kind is used in catching rabbits.

Spring Plank. (*Railway.*) A transverse timber beneath a truck bolster.

Spring Sad'dle. A clevis which holds an elliptic spring, as in some car-trucks where a spring rests upon the journal box.

Spring Seat. The support for the lower part of a spring, shaped according to circumstances.

Spring Shack'le. The couplings used in joining the transverse and longitudinal springs in the platform spring system for buggies.

Spring Sha'ping Ma-chine'. A device to supersede the method of pinching heated spring leaves or plates into form by means of tongs, consists of a solid and flexible former, supported on a bed-plate, and a system of cams, drop lever, and screw for shaping.

"*Scientific American*" . . . . . xxxvi. 374.

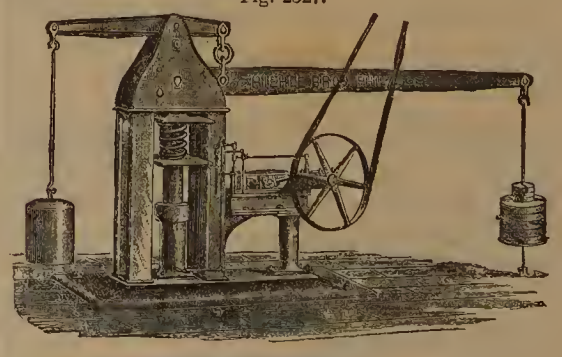
Spring Shelf. A ledge or bracket to afford a seat for a spring.

Spring Stud. A rod passing through the axis of a coil spring to hold the latter in place.

Spring Test'ing Ma-chine'. Fig. 2327 shows Riehlé Bros. machine for testing the elasticity of springs under pressure.

The power pump is operated by a pulley and belt. A lug projects from the corner of the lower table or compression surface; this lug intercepts a pawl that is connected with a valve that controls the flow of the fluid, and when the lower table moves upwards to the desired height, the fluid is diverted from under the plunger back into the reservoir, thus securing a uniform test.

Fig. 2327.



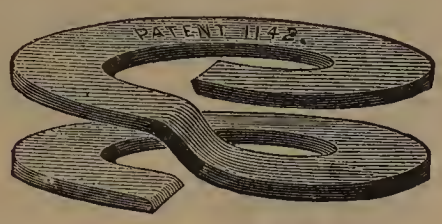
Spring Testing Machine.

The upper table bears against weighing levers, and is comparatively motionless, while the lower table moves upwards and communicates the pressure through the spring to the upper table, and thence to the levers and weights as shown.

Spring Valve. (*Steam.*) A spring balance is attached to the valve graduated to any number of pounds desired, and acts as a check on the valve till the indicated pressure is reached.

Spring Wash'er. A flat spiral spring is cut into sections of one or more laps, and used as

Fig. 2328.



Spring Washer.

a washer; will close up tightly and expand to take up looseness caused by shrinkage of woods or other cause.

Sprink'ler. A machine for spraying or irrigating plants; notably for destroying insects.

See Spraying Machine; Fountain Pump.

Robinson's combined sprinkler and duster for destruction of the cotton worm is shown in *Comstock's "Report upon Cotton Insects,"* 1879, * p. 252.

Sprinkler, automatic fire, *Conant*, * "*Scientific American*," xxxiv. 114.

Sprue Hole. (*Founding.*) A gate, ingate, or pouring-hole in a mold.

Spud. (*Surgical.*) (*a.*) A small instrument with an enlargement on the end, used in withdrawing foreign matters from the eyeball and orbit. It is not so pronouncedly hollow as the curette or spoon.

(*b.*) A dermal instrument of the same shape; used in scarifying.

Spun Glass. (*Glass.*) Drawn by a workman from a hot bulb, or, on a larger scale by means of a wheel. See Glass Spinning, p. 983, "*Mech. Dict.*"

In the Austrian section at the Paris Exposition was one of the attractions of the day, viz., the manufacture of toilet articles and stuffs for ladies' wear, made out of spun glass, by Madame Jules de Bruufaut, Vienna. The glass, shown on the counters in large bundles, to all appearance looks like cotton, and is of a remarkable fineness. This glass is spun into threads like ordinary cotton, and is woven into different colored fabrics, sometimes entirely of glass and sometimes with a chain of silk or cotton.

The novelty of seeing fancy articles made of spun glass attracted the eye of the visitor. Ladies were particularly astonished at seeing collars, neckties, cords and tassels, fringes, pin-cushions, little caskets, curled feathers, belts, etc., made of glass. A very handsome ladies' buff-colored bonnet, made of spun glass, with the orthodox feather and ribbons, lined with silk, was the center of attraction. A bonnet of this kind can run the risk of a shower without being spoiled; glass will only look brighter for being washed.

The exhibit included a very handsome cloak, made of knitted wool and lined with glass cloth, the threads being woven a certain distance apart and laid at right angles. This made a very pretty and bright lining, offering a pleasant contrast with the colored knitted wool. The different articles exhibited were made in various-colored glasses. There was quite a variety of colored and white laces; cloths embroidered with glass; very thin woven glass cloth, in which now and then a fine thread of gold-colored glass appeared, making a very handsome fabric. These goods are easily washed by simply dipping in a bath of water and soda, and brushed with an ordinary soft brush.

See Slag, *supra.*

Fr., *coton de verre;* Ger., *glaswolle.*

Spur. The far-projecting point on the circumferential edge of an auger. It makes the cut, while the *lip* raises the chip.

(*Ceramics.*) A small piece of refractory clay ware having one or more points, and used to support an article in the seggar while firing in the kiln. Also called a *stilt.* Fr., *colifichet.*

Sput. A thimble or annular reënforce to a hole in a boiler.

Squab Cush'ion. A cushion consisting of a bag filled with curled hair, feathers, or whatnot.

Square Tank Coil. A condensing coil of rectangular shape.

Squar'ing-off Saw. A circular saw, fitted to a bench with a sliding table, to square the ends of work.

Squar'ing Plow. For squaring paper in bookwork. The paper being placed on a table, with a board of required size on top, the paper is held firmly down by a screw having a bearing above. The board is provided near its edge with a groove or track for the plow or knife-carrier to travel in. The knife overhangs the board, and cuts the paper to size of the same.

Squar'ing Shears. (*Sheet-metal Working.*) A machine for squaring up tinned plate. It has scales of inches upon the adjustable table, and similar scales upon the arms that support the back gage, which latter has a rack-and-pinion adjustment.

The blade and treadle are balanced by an adjustable counter-weight; the treadle-springs are relieved of the weight of those parts, their only duty being to quicken the return movement of the blade. Page 110, "*Bliss's Catalogue,*" 1881.

Another form has two blades set at right angles one with the other, and moving in unison, so that a sheet of tin may with one motion be squared on two sides, or the whole sheet squared in two motions. There are suitable front gages as well as independent back gages, one for each blade.

The gage on one blade can be set to cut a different width from the other, so that part of a sheet of metal can be cut up into a certain width for one article, and the remainder into a different width for another article.

Squaring shears, *Stiles & Parker*, * "*Scientific Amer.*," xl. 82.

(*Bookbinders.*) A curved hand-shear for squaring paper and cardboard is pivoted at one side of a table, and is held up by a balance-weight. The operator adjusts the material to be cut, and bears down on the handle of the shear. A foot treadle presses on the paper alongside of the shear to keep it firm.

Squeez'er. In sheet-metal working, a machine for squeezing or crimping, on the tops and bottoms of sheet-metal cans. See illustrations, p. 90 *et seq.*, "*Bliss's Catalogue,*" 1881.

A series of compressing walls, to consolidate and clear of cinders the large masses of crude wrought-iron often produced in the process of puddling.

Menelaus . . . . . "*Scientific American Sup.*," 1284.
Squeezer, *Head*, Br. . * "*Engineer*," xliii. 358.
Iron, *Head* . . . . "*Iron Age*," xx., July 5, p. 9.
Squeezing, puddlers' balls mach., *Suckors* * "*Scientific American Sup.*," 1233.

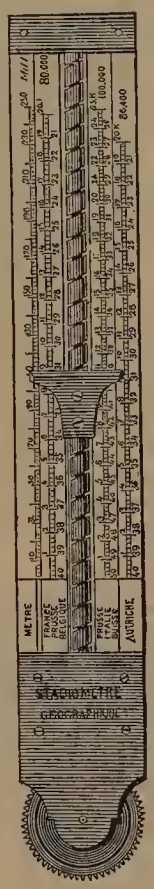
Sta-di-om'e-ter. The geographic stadiometer devised by Captain Bellomayee, is designed to show at a single reading the measure of any line, right, curved, or broken, on maps or charts executed on any scale. The toothed wheel shown at the bottom is moved over the line and imparts motion to the longitudinal screw. This, in rotating, causes the ascent or descent of the carriage, the straight edge of which serves as an index.

Eight scales are used, one of 1-80000 for Prussian, French, and Belgian maps; one of 1-100000 for Prussian, Italian, and Swiss maps; one of 1-86400 and another of 1-144000 for Austrian maps; two respectively of 1-21600 and of 1-424000 for Russian maps; one of 1-63360 for English maps, and finally a graduation corresponding to the natural metric scale. This last marking by a simple reduction allows of the instrument being used for maps constructed on any other scale than those mentioned.

The device is held in the hands like a pencil, and as the

wheel runs over the line it is only necessary to read the distance traveled on the proper scale to know the exact length of the line. When the index reaches the top of the screw, the instrument is turned around and pushed forward as before, the marking being now read from the top downward instead of in the reverse direction. It is especially useful in the field for military operations, as it does not require the entire map to be spread out flat before it can be used. It of course obviates the employment of dividers, and the usual scale of distances printed on charts.

Fig. 2329.



Stadiometer.

Sta'di-um. The leveling rod of a surveyor. See illustration, "*Van Nostrand's Mag.*," xxi. 141, 142.

Staf'ford-shire Ware. (*Ceramics.*) Household earthenware made in Staffordshire, in England, where pottery had been made as far back as the Roman period.

The red ware of the brothers Elers, from the Netherlands, was the beginning of the new era for the district. Delft was copied; then came Wedgewood, who made the greatest improvements due to one man, so far as we know the history of the art.

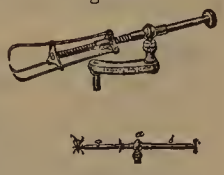
He improved and decorated the old wares; in 1762 invented the *cream* or queen's ware (not the modern invention), made of clay and silex with a clear glass glaze. In 1766 he made his black basalt ware. In 1773 he invented the fine paste for cameos, reliefs, and statuettes, which came to be known as jasper ware.

The queen's ware or ironstone china is perhaps the best known of Staffordshire wares, though many others are made in that country.

See STONEWARE.

Stage For'ceps. Adjustable clamps for fitting on to one side of the stage of a microscope to hold an object for examination.

Fig. 2330.



Stage Forceps.

Stage Mi-crom'e-ter. (*Optics.*) A piece of glass upon which fine lines are engraved, usually of 1-100 and 1-1000 of an inch or parts of a millimeter. It is placed on the stage of the microscope and used for the measurement of objects.

Stain'ing. (*Leather.*) Applying with a hair brush to the grain side of leather a solution of logwood, sal-soda, and soft water. It gives a dark color to the leather.

Stain'ing Met'als.

Metals may be colored quickly and cheaply by forming on their surface a coating of a thin film of sulphide. In five minutes brass articles may be coated with any color, varying from gold to copper-red, then to carmine, dark-red, and from light aniline-blue to a blue-white, like sulphide of lead, and at last a reddish-white, according to the thickness of the coat, which depends on the length of time the metal remains in the solution used. The colors possess a very good luster, and if the articles to be colored have been previously thoroughly cleaned by means of acids and alkalies, they adhere so firmly that they may be operated upon by the polishing steel. To prepare the solution, dissolve one-half ounce of hyposulphite of soda in one pound of water, and add one-half ounce of acetate of lead dissolved in a half pound of water. When this clear solution is heated to from 190° to 200° Fah., it decomposes slowly, and precipitates sulphide of lead in brown flakes. If metal be now present, a part of the sulphide of lead is deposited thereon, and, according to the thickness of the deposited sulphide of lead, the above colors are produced. To produce an even coloring, the articles must be evenly heated. Iron treated with this solution takes a steel-blue color; zinc, a brown color; in the case of copper objects, the first gold color does not appear; lead and zinc are entirely indifferent. If, instead of the acetate of lead, an equal weight of sulphuric acid is added to the hyposulphite of soda, and the process carried on as before, the brass is covered with a very beautiful red, which is followed by a green (which is not in the first scale of colors), and changes finally to a splendid brown with green and red iris glitter. This last is a very durable coating, and may find special attention in the manufactures, especially as some of the others are not very permanent. Very beautiful marble designs can be produced by using a lead solution, thickened with gum tragacanth on brass which has been heated to 210° Fah., and is afterwards treated by the usual solution of sulphide of lead. The solution may be used several times.

Stain'ing Wood. Oak may be dyed black, and made to resemble ebony, by the following means: —

Immerse the wood for 48 hours in a hot saturated solution of alum, and then brush it over with a logwood decoction, as follows: Boil one part of the best logwood with 10 parts of water, filter through linen, and evaporate at a gentle heat until the volume is reduced one-half. To every quart of this add from 10 to 15 drops of a saturated solution of indigo. After applying this dye to the wood rub the latter with a saturated and filtered solution of verdigris in hot concentrated acetic acid, and repeat the operation until a black of the desired intensity is obtained.

Stains for wood, *Black*. "*Scientific American Sup.*," 1994.

Stake. The stanchion, standard, or post placed in a socket on the edge of a gondola or flat car to hold sideboard or freight, as the case may be.

Stake Hook. The clevis or iron loop on the edge of a platform car to hold the stake or stanchion.

Stake Net. (*Fishing.*) A net secured by stakes.

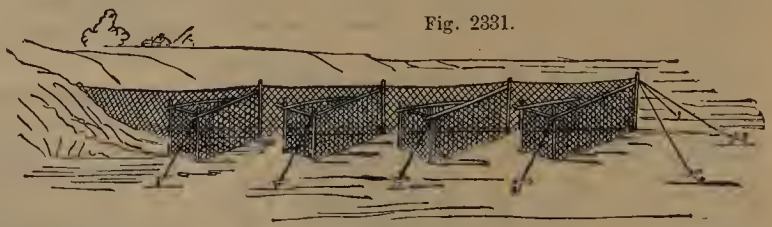
In the example, it is hung on stakes about 21′ apart in a line at right angles to the shore. This part of the net is known as the *bar*-net. At from 30′ to 40′ down stream another row of stakes is set, each opposite a stake in the *bar*-net, and between these stakes a *wing*-net is stretched, having several yards of netting more than suffices for the distance. This end is carried round in the form of a triangle and held in position by poles lashed together at their ends. The free end of one pole is secured to the stake, and of the other to the seaming of the wing-net, and thus secured they float at the surface of the stream.

The triangular portion of the wing is arranged so as to allow an opening between the end of the *hook* and the *wing* through which the salmon enter the triangle.

The netting is made of strong gilling-twine, the minimum mesh allowed being 5″.

The salmon, swimming up the current, come in contact with the bar-net, and turning to pass around it, find themselves opposed by the *wing*; they turn again up-stream, and are pretty certain to enter the *hook*, the netting of which hangs slack. In their efforts to escape they become gilled.

Fig. 2331.



Staked Gill-net for Salmon on the St. Lawrence.

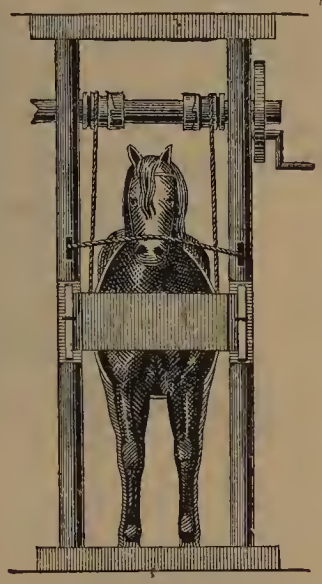
A gill net set in a channel attached to stakes. Such are very common in the Potomac and other Atlantic rivers.

Stall. Fig. 2336 shows a stall for transporting horses or cattle on ship or cars.

Each horse has his own separate box and sling. A shaft runs along above the row of stalls, and on this are loose clutch-pulleys, to which the ropes of the several slings are attached. These pulleys can be clutched with a corresponding clutch on the shaft, and any one or all the horses

swung from the floor at will. The sides of the stall are of stout canvas.

Fig. 2332.



Stall.

Stamp. (*Mining.*) Machines for crushing ores.

The old practice of running high stamp-heads at a low speed and high drop has been changed by Western mill men, who erect heavy stamp-heads working at a high speed with a low drop, claiming that they get better results. The weight of a heavy head may be taken at 700 pounds, medium drop of head 10″, number of drops per minute for high speed, 90.

* "*Scientific American Sup.*," 1512.

Stamp, *Ball.*
* "*Min. & Sc. Press*," xxxiv. 337, 345.

Cauceler, electr., *Dow.*
* "*Scientific Amer.*," xl. 38.

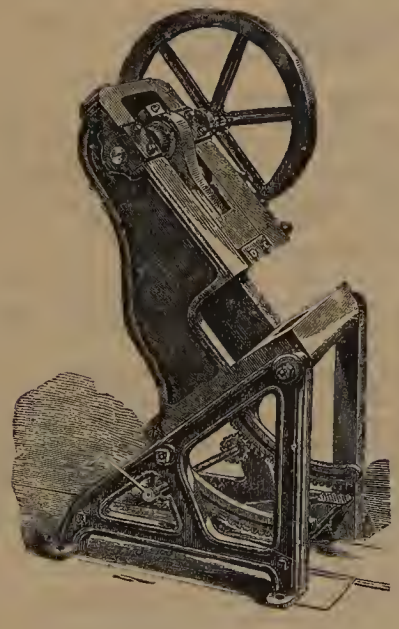
Canceling . . . . . "*Iron Age*," xix., Jan. 25, p. 19.

Stamp'er. A machine used in cleaning or filling textile goods. It may have one or more oak tubs about 3′ in diameter, with fallers or stampers of birch, while the framing is of pine bolted together. The tub is fixed on an iron plate which revolves by gearing, while the stampers are lifted by cams and are released so as to fall in succession on the goods being operated upon.

Stamp'ing Ma-chine'. For stamping the soles of boots and shoes with monogram or trade-mark.

Stamp'ing Press. A press for stamping or punching sheet metal.

Fig. 2333.



Stamping Press.

In the Stiles & Parker press, see Fig. 2333, the bed of the press is hinged to the A-frame at the front edge. The inclination is secured by means of a toothed wheel and a curved rack. The hinge around which the bed of the press turns when it is inclined is at the front edge of the bed, so that this edge does not change its level nor position when the press is inclined.

The adjustment of the slides in the guides is made by a very neat arrangement of a V-shaped liner, put into the guide in such a way that it takes up the wear upon the side where the wear comes. As the diagonal pressure in these presses is, owing to the length of the connecting rod, or pitman, very slight, the wear is merely nominal.

The pressure from the eccentric is transmitted to the slide in the form of compressive strains entirely, the end of the pitman bearing in a cup-shaped hollow, the pin merely serving to lift the slide by. The adjustment of the press is secured by a couple of eccentrics, one of which is movable about the other. By loosing the clamp screws shown in the top of the pitman, the outer eccentric may be turned so as to obtain any desired throw, after which the screw is set up and the press is ready for operation. This method gives exceeding delicacy of adjustment, and makes the press capable of doing work of the most difficult character.

Presses of this kind are capable not only of punching plate iron, but of decorating silver-ware. The two operations are fair examples of the extremes of coarse and fine work, though both require about the same amount of power and equally heavy pressures.

Stamping press, *Gordon* * "*Iron Age*," xxiii., Feb. 6, p. 9.
Stiles & Parker . . . * "*Iron Age*," xxiv., Sept. 4, p. 1.
Bliss & Williams . . * "*Scientific Amer.*," xxxix. 406.
Stiles & Parker . . . "*Scientific American*," xxxix. 69.
Foot, *Ferracute Co.* . * "*Iron Age*," xix., April 26, p. 23.
Foot and hand, "Peerless" . . . . . * "*Iron Age*," xxiv., Aug. 28, p. 1.

Stamp Mill. A mill for reducing ores to a comminuted state preparatory to extracting the precious metals by amalgamation.

This ore is worked by the wet amalgamation process. The ore is introduced in an automatic feeder, and is fed under the stamps as required.

It is stamped fine enough to discharge through a screen containing 120 holes to the square inch. Water is turned in the battery at the same time the ore is fed in, and the splash as the stamps drop causes it to discharge, and the water carries the crushed ore with it to the tanks, where it settles.

The battery consists of 5 stamps of 775 lbs. each; they are raised by cams on a revolving shaft, and drop 8″, at the rate of 95 drops per minute. The shoes and dies are of cast steel, and weigh 120 lbs. each. The mortar in which the stamps work is made of cast iron, and weighs 4,400 lbs.

The crushed ore is taken from the tanks, put in the grinding and amalgamating pan, heated by steam, in order to soften the sand, and assist amalgamation. It is ground here for three hours; the grinding muller revolving at the rate of 90 revolutions per minute. The mercury introduced and amalgamated for two hours more. The mass is then drawn off into the settler below, water turned in to cool it, and is stirred by the revolving shoes for two hours and a half, bringing all the particles of mercury together in a mass at the bottom. With the bottom is connected an inverted siphon-pipe, that conducts the mass of mercury containing the amalgam into an iron bowl; from there it is strained through a canvas sack, the mercury going through, and the amalgam containing the gold and silver remaining in the sack. It is then in a condition to be handled, and contains about four fifths of its weight in mercury. It is then put in dishes in an iron retort, placed in the furnace with the pipe at the end to conduct the mercury out. Fire is made in the furnace, and the heat drives off all the mercury, which is condensed and used over again. The bullion is left in the retort, and when taken out is ready to go to the mint for melting.

Ball's patent steam stamping machinery for stamping ores and minerals (see Fig. 2334), is a direct acting vertical stamp mill having a common steam cylinder and slide valve at the top, and the piston rod extended into the stamp stem which works in a cast-iron mortar supported on spring timbers resting on cast-iron sills.

The lower portion of the mortar is circular in form, the upper portion being oblong, with a flat top and vertical sides; on the front and back sides are inclined openings for receiving the screens. The mortar is cast in one piece, and is lined throughout with hard iron linings. There are two feed-hoppers bolted to the top of the mortar, through which the ore is fed to the mortar.

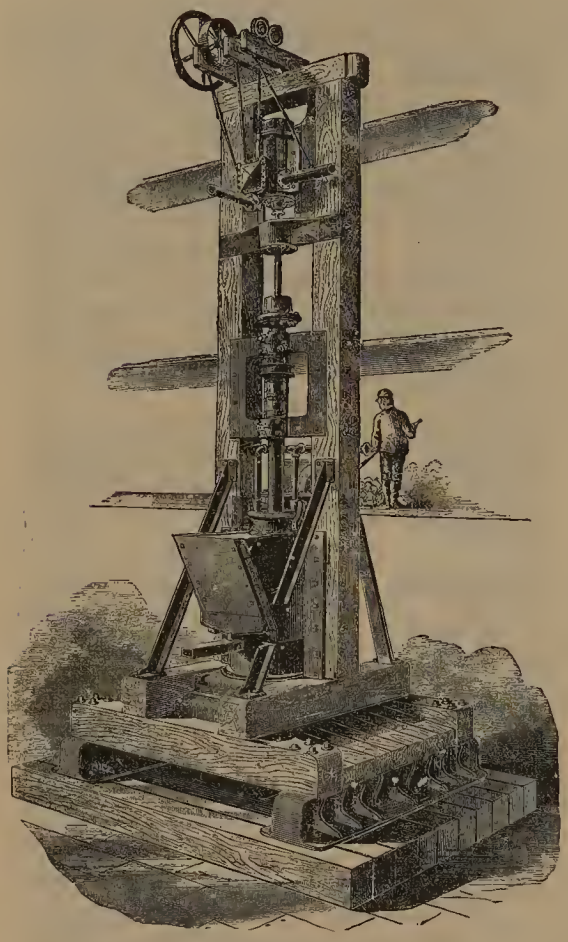
There is also a water urn arranged about a circular opening in the center of the top of the mortar, through which the water is conducted to the mortar.

The stamp shaft or stem works through two boxes which are attached to an iron frame that is bolted to the two upright posts that form the main framework of the machine.

Between the boxes and about the stamp-shaft is a revolving clamp and pulley, having feathers which work in splines in the stamp-shaft; and, by means of a belt on the pulley, a rotary motion is given to the stamp-shaft during its upward and downward motion.

The piston rod passes from the steam cylinder downward through the center of the bunter beam, and into the stamp-

Fig. 2334.



Stamp Mill.

shaft bonnet in which the connection to the stamp-shaft is made. The bunter beam contains a cushion against which the top of the stamp-shaft bonnet would strike, should the stamp-shaft lift too high.

The slide-valve works independent of the stamp-shaft, running a regular number of strokes per minute, and is driven by an eccentric on a shaft, which receives its motion from a countershaft; the two shafts being geared together with two cam gears, by means of which the motion of the eccentric shaft is changed into an irregular motion, and gives the eccentric and steam valve a motion corresponding to the slow upward and quick downward movement of the stamp-shaft.

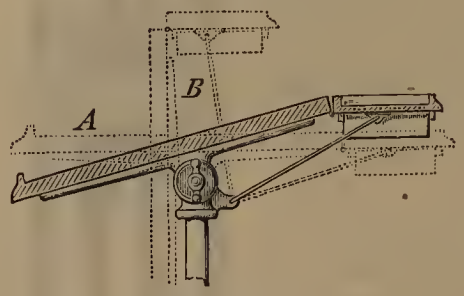
Stamp mill, "Elephant" * "*Min. & Sc. Press*," xxxvii. 81.
Kendall . . . . . * "*Min. & Sc. Press*," xxxvii. 112.
For silver ores (80-stamp), Peru . . . * "*Engineering*," xxviii. 359.
Rotary, *Taylor* . . . * "*Min. & Sc. Press*," xxxvi. 193.
Stamp mills, Cal. . . . * "*Engineering*," xxx. 19, 85, 163, 254, 338.
Cam for mill stamps.
Cochrane . . . . . * "*Min. & Sc. Press*," xxxv. 81.
Cam for stamp mills.
Moore & Dykes . . . * "*Scientific American*," xlii. 169.
Cams for stamp-mills:
consideration of single and double arms . . * "*Scientific American Sup.*," 1512.
"*Mining Journal.*"

Stamp Mu'cil-age. The following is said to be the formula for the mucilage used on the United States postage stamps: Dextrine, 2 oz.; acetic acid, 1 oz.; water, 5 oz.; alcohol, 1 oz. Add the alcohol to the other ingredients, when the dextrine is completely dissolved.

Stamping mill, *Ball* . . * "*Eng. & Min. Jour.*," xxii. 359.
Rotating, *Fisher*, Br. * "*Engineering*," xxx. 371.
* "*Scientific American Sup.*," 4135.

Stand. 1. For holding materials for drawing or painting. The Washburn stand, manufactured at Worcester, Mass., can be fixed at any required height, so that one can use it either sitting or standing; and by turning back the screw at the right, it is allowed to rotate, bringing either side in front. The shelf or ledge for instruments is attached to the back side of the table, so that it is always level, whatever inclination is given to the desk; convenient for the water-cups, ink-stands, etc. Fig. 2335

Fig. 2335.



Washburn Stand.

shows the table fixed at a slight inclination, the dotted lines showing it horizontal at *A* or vertical at *B*. When the table is nearly vertical the whole occupies but little space, and forms a perfect easel. When used for this purpose an attachment is furnished for holding the picture, and the adjustments are so simple that a mere touch is sufficient to effect an entire change in the light which falls upon the work. Under the instrument shelf are provided two drawers for working materials. The table and drawers are made of black walnut or other appropriate wood, nicely finished.

2. (*Microscopy.*) The framework of a microscope, usually implying all save the object glasses and the accessory apparatus.

Stand'ard Bat'te-ry. (*Electricity.*) One to be used as a standard, having a perfectly constant electro-motive force.

Such an one is Latimer Clark's battery, described in "*Phil. Trans. Royal Society*," June 19, 1875.
Niaudet, American translation, 148.

Stand'ard Gage. (*Railroad.*) "Standard gage" means 4′ 8½″ between centers of rails.

Stand Pipe. A vertical pipe in which a column of water is made to rise to give sufficient head for forcing the water to elevated portions of the circuit. See "*Mech. Dict.*," p. 2308.

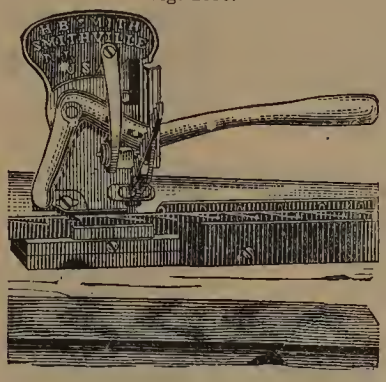
Stand-pipe, Bloomington, Ill. . . . . * "*Scientific American Sup.*," 164.
* "*Engineer*," xli. 51.
Centennial . . . . * "*Scientific American Sup.*," 233.
Sandusky . . . . * "*Scientific American Sup.*," 1746.

Stand Pipe Fire Ap'pa-ra'tus. A portable stand-pipe for obtaining a higher head of water at fires. One section of a pipe is attached permanently to trunnions; other sections are carried in a side rack and attached at the fire. The pipe, 50′ long or more, is raised by means of a wheel after coupling the hose. The lower end is attached to the water supply. Less power is required at the engine to raise the water.

Staph'y-lor'a-phic Ap-pli'ance. *Dr. Gummings'* appliances for congenital cleft palate, * *Dr. J. H. Thompson's* report in "*Centennial Exhibition Reports*," vol. vii., Group XXIV., p. 28.

Sta'ple Dri'ver. An instrument for driving the staples in window-blinds. The one shown in Fig. 2336 feeds the blind the proper distance, supplies the staple, and drives it either in the rod or slat as desired.

Fig. 2336.



Staple Driver.

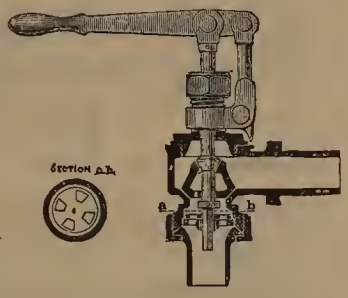
Sta'ple Fas'ten-er. A spring punch for driving and clinching a staple against an anvil block beneath.

Star Feed. A star-shaped device for improvising a feed motion to a slide-rest or to a tool-holding device not actuated by the self-acting feed motion of a lathe or machine. Upon the outer end of the feed screw of the slide-rest a star-shaped plate is fastened. For a slide-rest feed a pin is fastened to the lathe face-plate in such position that it will strike one of the star wings at each revolution.

For a revolving boring bar the pin is stationary and the star revolves with the feed screw of the bar.

Start'ing Valve. The starting valve, shown in Fig. 2337, is operated by a lever; its stem is attached to the valve with a lost motion, and has a small valve in the center of a larger valve. Pressure of the boiler is on top of the valves. Raising the lever and drawing up the valves, the small valve will leave its seat and rise until a check nut has brought up against *d*. This resistance can be distinctly felt, and indicates when the small valve only is open. Through this small valve enough steam will pass to start the jet. A further motion of the lever then raises the large valve, and the pressure, acting on the steam, forces it wide open and holds it in this position.

Fig. 2337.



Starting Valve.

Star Tor-pe'do. A movable chamber or mine charged with an explosive that is fired by contact or by fuse. The star torpedo has a single platinum fuse and battery and one set of wires, and can be fired either on contact or at will as desired. There are two wires leading from the opposite poles of the battery to a contact maker on the nose of the torpedo, by which contact is made between the wires whenever the torpedo is touched by the vessel attacked, and the current thus being free to pass through the fuse, the torpedo is thereby exploded.

Torpedo, *McEvoy*, Br. . . . * "*Engineer*," xliii. 340.

Stath'mo-graph. An instrument invented by Dato, of Cassel, for recording the velocity of railway trains.

"*English Mechanic*" . . . . . xxv. 229.

Sta'tic E'lec-tri'ci-ty. (*Electricity.*) Electricity at rest.

Sta'tion-a-ry Bed Pla'ner. The bed is stationary, and the stuff is fed by feed-rollers. The bed has sliding rollers, flush or a little above its face.

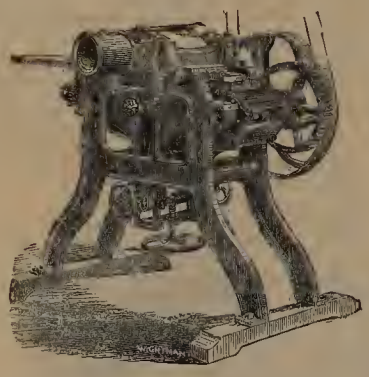
Sta'tion In'di-ca'tor. An indicator operating in connection with the driving-wheels to exhibit automatically the name of the station or street immediately preparatory to arrival.

Sta'tion Me'ter. (*Gas.*) A meter of the largest class for measuring the flow of gas at the works; made from 30″ wide and 30″ long, to 15′ × 15′, of a capacity from 15,000 cubic feet to 2,000,000, per 24 hours. The smaller are in one cylinder and the larger in two sections. They are made with water-line, pressure, and overflow gages, and register clock and tell-tale attachments. The tell-tale tells at a glance any irregularity of manufacture during the 24 hours, the cards being attached and removed daily.

Stave Dress'ing Ma-chine'. This machine has a rotary cutter-head and revolving bed with continuous motion.

The stave is placed on the bed and carried forward in a direct line to the rollers, which are straight, convexed, or concaved, to fit the shape of the stave.

Fig. 2338.



Holmes's Machine for Dressing Sawed Staves.

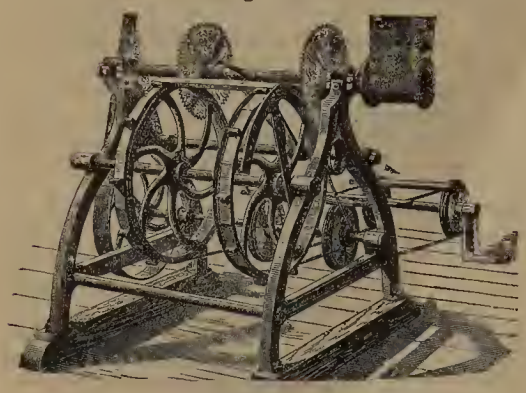
The rotary head cutters are so made as to smooth and finish the stave, perfect its shape, and give it uniform thickness. The form may be changed at pleasure and may be made to operate upon one or both sides of the stave.

Revolving cutters are used for dressing staves of all thicknesses; dressing both sides of the staves at the same time without cutting the wood across the grain, that is, leaving the staves winding and crooked as they were rived from the block. This is accomplished by allowing the frame, which supports the cutters, to oscillate or rock in all directions, by which the cutters adapt themselves to the crooks and winds of the stave, the stave having control of the cutter frame. It dresses rived and sawed staves of different lengths and curves, for making kegs, barrels, and hogsheads, and dresses crooked and winding stock to a uniform thickness, leaving it concave and convex as required.

Stave dresser, barrel.
Holmes . . . . . * "*Engineer*," xli. 431.
Jointer, *Holmes* . . . . . "*Engineer*," xli. 431.
Jointing machine, Br.
Richards . . . . . * "*Engineering*," xxiii. 139.
Saw, *Ransome* . . . . . * "*Engineering*," xxi. 452.
Shaper & bender.
Ashey, Fr. . . . . * "*Engineer*," xlvii. 255.

Stave E'qual-i-zer. In Holmes's equalizer, Fig. 2339, the feed is continuous, the staves being simply laid upon the reel, which passes them between the saws and delivers them on to the stave conveyer, which carries them where they are needed.

Fig. 2339.



Barrel Stave Equalizer and Conveyer.

Stave Ma-chin'e-ry. See list under BARREL MACHINERY.

Stay End. The end of a back-stay in a carriage. Stay-ends are sold separately as pieces of carriage hardware, the lengthening rod being added by the blacksmith.

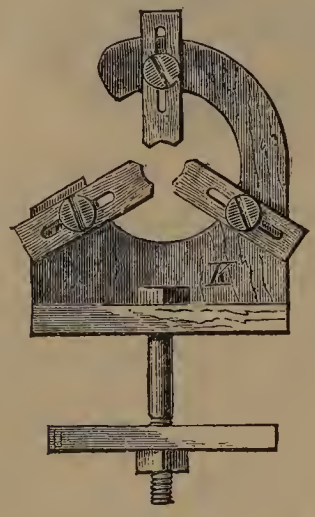
The ends of the stay are bolted or clipped to the perch and hind axle respectively.

Stay End Tie. The rod which connects the stay-end on the reach with the one on the axle.

Stay Rod. A rod which connects two objects to prevent displacement of one or both.

Stead'y Rest. For centering a cylindrical piece in a lathe, slotted pieces are adjustable lengthwise to accommodate the size and position of the shaft.

Fig. 2340.



Steady Rest.

Steadying tools, lathe work, * "*Scientific American*," xl. 100.

Steam. For appliances, machinery, and uses, see the following references: —

Steam building crane .
Florio, Palermo . . * "*Engineer*," xlvi. 369.
Brake, continuous.
Kendal, Br. . . . * "*Engineer*," xlviii. 272.
Canoe, *Roper*, 14′ × 17″ × 12″ . . . . . "*Scientific American*," xl. 261.
Car, *Ransomes*, Engl. * "*Scientific American*," xli. 50.
Clyde, "Lord of the Isles" . . . . . * "*Scientific American Sup.*," 1525.
On common roads . . "*Scientific Amer.*," xxxix. 96.
Steam crane, *Appleby*, Engl. . . . . * *Thurston's* "*Vienna Rept.*," iii. 335.
Caillard, Fr. . . . * "*Engineering*," xxvii. 123.
60-ton, St. Petersburg * "*Engineering*," xxv. 64.
Locomo., *Janson*, Br. * "*Engineer*," xlix. 160.
Portable, *Brown Bros.*, Eng. . . . . * "*Scientific American Sup.*," 932.
Brown, Br. . . . . * "*Engineer*," xlii. 428.
Burrow, Engl. . . . * "*Scientific American Sup.*," 3879.
Steam digging-engine.
Darby, *Br*. . . . . * "*Engineer*," xlvi. 43.
Escape, quieter . . See QUIETING CHAMBER.
In factories . . . . . * "*Iron Age*," xxv., Jan. 1, p. 1; Jan. 8, p. 1.
Ferry, "*Iron*," *Egerton*, Eng. Channel . "*Van Nostrand's Mag.*," xiv. 284; xv. 92.
Ferry steamer, light draft, *Denny*, Br. . * "*Engineering*," xxviii. 377.
Fire-engine boiler. *La France* . . . . . * "*Scientific American*," xlii. 404.
Fittings factory . . * "*Scientific American*," xliii. 367.
Fitting, piping a building . . . . . * "*Scientific American*," xli. 355.
For common roads (Wisconsin law). . "*Scientific American*," xxxiv. 64.
Generator, *Franke* . * "*Scientific American*," xliii. 115.
Ward . . . . . * "*Scientific American*," xli. 323.
Goode . . . . . * "*Am. Man.*," Feb. 28, 1879, p. 6.
Herreshoff . . . . * "*Engineering*," xxvii. 122.
Horse for street R. R. * "*Scientific American*," xxxiv. 51.
Steam and hydraulic press, direct acting. *Tweddell*, Br. . . * "*Engineering*," xxv. 92.
Steaming app. for printed textiles, *French* . * "*Scientific American Sup.*," 2274.
Steam, light draft, *Yarrow & Co.*, Br. . . * "*Engineering*," xxiii. 45.
Steam launch gager . . * "*Engineer*," xlix. 121.
Outtridge . . . . . * "*Engineer*," xlix. 439.
Engine, *Selfe*, Sydney * "*Engineering*," xxi. 129.
Pressure gage, *Edson* * "*Am. R. R. Journal*," li. 288.
Stewart, Br. . . . . * "*Engineering*," xxvii. 37.
Dewrance, Br. . . . * "*Engineering*," xxvii. 100.
Indicator, *Darke* . . * "*Engineering*," xxix. 241
Regulator for portable engines, *Stannah*, Br. * "*Engineer*," xlix. 421.
Road wagon . . . . "*Scientific Amer.*," xxxix. 208.
Scoop-excavator.
Fowler, Br. . . . * "*Engineer*," xlvii. 475.
Stop valve.
Cormack, Br. . . . * "*Engineering*," xxv. 221.
Towage, Illinois canal * "*Eng. & Min. Jour.*," xxiii. 109.
Water in, measurement of, *Guzzi* . . . . * "*Scientific American Sup.*," 1807.
Whistle signaling inst. "*Telegraphic Journal*," iv. 178.
Yacht "Livadia," Rus. * "*Scientific American Sup.*," 3866.
* "*Engineer*," l. 24, 45, 48.
Stearing gear.
Lafargue, Br. . . . * "*Engineer*," xlvi. 71, 83.

Steam'boat. For sketch of the progress and history of steamboat building, see "*Mech. Dict.*," pp. 2321–2326.

Steamboat, Symington Engine . . . . . * "*Scientific American Sup.*," 711.
Engines, early Amer. * "*Engineering*," xxviii. 327.
"Clermont." "Chancellor Livingston."
Engine, light draft.
Wilson & Co., Engl. * "*Scientific American Sup.*," 1220.
Early history . . . "*Iron Age*," xix., June 7, p. 5.
Fulton. *Bell.*
"Grand Republic" . "*Scientific American Sup.*," 1921.
On Mississippi, first . "*Scientific Amer.*," xxxvi. 20, 68.
First voyage of Fulton's "*Iron Age*," xxii, July 4, p. 3.
For shallow water.
"Silva Americano" * "*Scientific American Sup.*," 1486.
Towing, Ohio river
"J. B. Williams," . * "*Engineer*," xli. 416. 420, 428, 434.
Speed, Engl. . . . "*Scientific Amer.*," xxxix. 193.
Steamboats, Fulton's letter . . . . . "*Scientific Amer.*," xxxvi. 388.
Small, *Firth* . . . . "*Scientific Amer.*" xxxix. 325.
Unsinkable.
Thompson, Engl. . * "*Scientific American*," xxxix. 18.

Steam Boiler. A vessel in which water is converted into steam, to be used as a power, a medium, and for other purposes. For early forms of steam generators and the adaptation of steam to mechanical and other uses, see "*Mech. Dict.*"

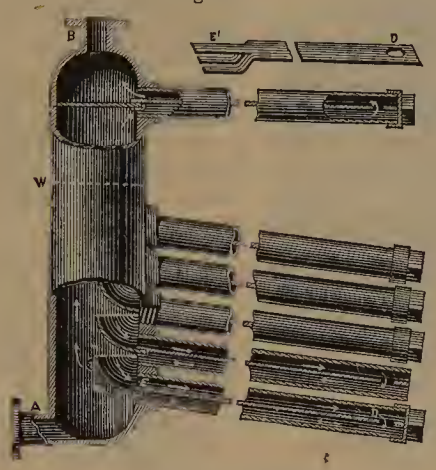
Of boilers of later construction, and unnoticed in the original volumes of the "*Mechanical Dictionary*," we have the "Corliss," an upright tubular boiler, with a cylindrical shell.

The "Exeter" has a series of sections, each a boiler in it-

self, rectangular in form. Each section has twelve openings, and is practically a series of connected boxes.

In the "Kelly" (see Fig. 2341) sectional safety boiler, the front chamber of each section is vertical, and the tubes are inclined over the fire at an augle of about one to eight. In

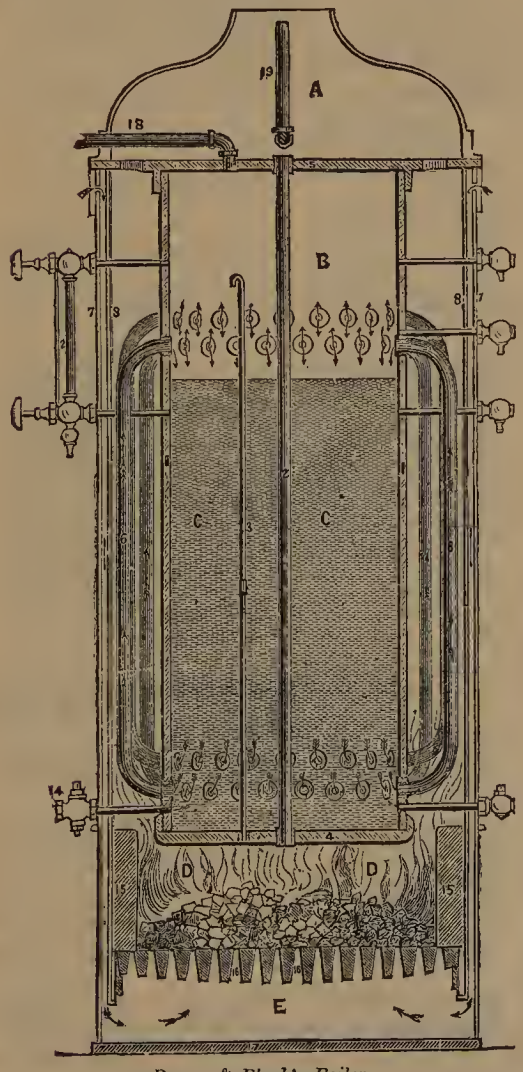
Fig. 2341.



Kelly's Steam Boiler.

each tube there is a partition with diaphragm, and the water-line of the boiler is above all the water tubes, but below a horizontal tube for the superheating of the steam. The

Fig. 2342.



Rogers & Black's Boiler.

theory of the circulation of the water is that the lower portion of the tube will be the most highly heated, and so generate the most steam, which, being intercepted by the partition plate and prevented from rising to the upper part of the tube, passes along the lower side of the partition to the front chamber and thence to the dome.

"Lowe's" tubular boiler has a cylindrical shell and horizontal tubes, like those of a locomotive boiler, through which the heated air and gases pass. Thence the hot air is carried round and under the boiler in front.

The "Howard" sectional safety boiler has tubes inclined from front to rear, with wrought iron steam drum.

"Root's" sectional boiler has an automatic feed regulator regulating the supply of water to the boiler by admitting steam from the boiler into the regulator when the water falls below a certain level.

The "Babcock & Wilcox," is a sectional tubular boiler with horizontal steam and water drum. The tubes are staggered. The end connections are each cast in one piece of steel, and connected with the steam and mud drums by short tubes expanded into bored holes, doing away with bolt connections.

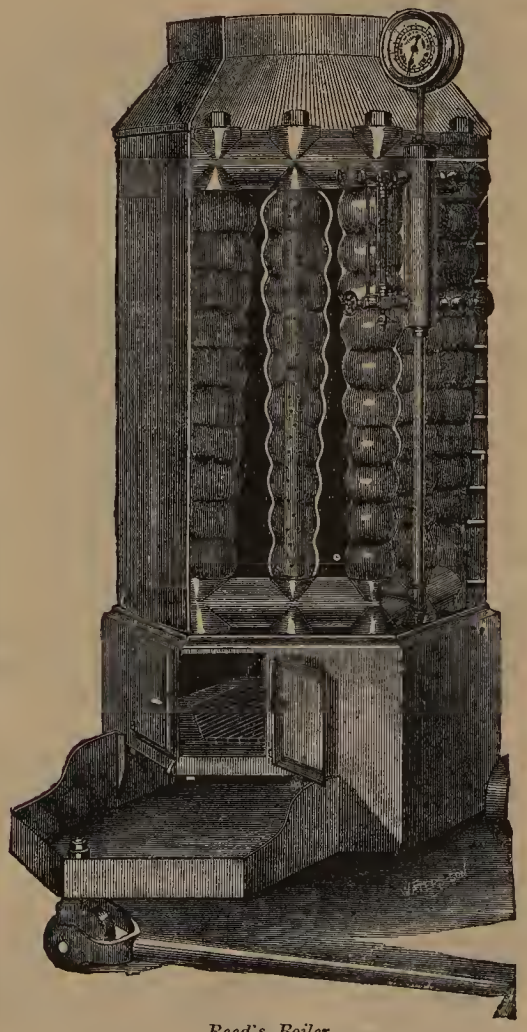
The "Firmenich," is an upright tubular boiler. The base is two large mud drums, one on each side, but two feet below the fire grate. From these rise obliquely over the fire, stacks of wrought iron water tubes that end in two water and steam drums, which are connected with a steam drum in the center, forming the crown of this pyramidal structure.

The "Pierce" boiler is a cylindrical, tubular boiler. The outer row of tubes are nearly surrounded by buckets that keep them submerged in water, and also drench the inner surface of the boiler shell above the water line.

The "Anderson"; each section of this boiler has two front manifolds, and a rear one connected by horizontal sets of tubes. The sections are united to each other by nipples, and the sets of sections by a central column, to the top of which is attached the steam dome.

The "Rogers & Black" (see Fig. 2342), is a cylindrical boiler with tubes outside for heating and circulation.

Fig. 2343.



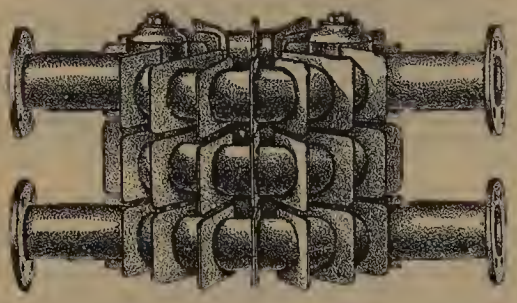
Reed's Boiler.

The "Reed" (see Fig. 2343) is a corrugated sectional boiler. The sections are of cast iron, being three corrugated pipes, joined at the bottom, top, and at the water-line.

The "Sectional Ring Boiler" (see Fig. 2344) is a cylindrical manifold boiler of unique arrangement.

The "Lynde" generates its steam in tubes that return over the fire seven times, and has a large steam drum. It has an eclipse injector, acme governor, and stop-valve, and Lynde's low-water alarm.

Fig. 2344.



Sectional Ring Boiler.

The "Eclipse" is adapted to either heavy or light service. The castings are of charcoal iron and the tubes lap-welded. All the parts being iron to iron, no calking or packing is required. A large steam drum is attached to the boiler.

In the "McLauthlin" the two heads are stayed by vertical braces, and the smoke bonnet has its aperture over the center of the boiler. The feed-pipe extends across the boiler inside far above the tube-sheet, and is perforated so as to secure extended distribution of the feed-water in minute jets pointing upward.

Steam boiler and superheat, steamer "Ban-Righ," Br. * "*Engineering*," xxii. 48.
Steam boiler. * "*Man. & Builder*," ix. 100; xi. 78.
Babcock & Wilcox . . * "*Eng. & Min. Jour.*" xxv. 358.
Belleville Boiler Co., Fr. * "*Engineering*," xxv. 341, 358.
Connolly . . . . . * "*Am. Man.*," Jan. 16, 1879, p. 13.
Cooper, Br. . . . . * "*Scientific American Sup.*," 1047.
Comp. Twis-Lille, Fr. * "*Engineering*," xxvi. 251.
Haywood, Tyler & Co., Br. . . . . * "*Engineering*," xxvi. 254.
Daly . . . . . * "*Scientific American*," xl. 342.
Davies, Br. . . . . * "*Engineering*," xxi. 176.
"Elephant," *Hall*, Br. * "*Engineer*," xlvi. 135.
"Eclipse" . . . . . * "*Am. Man.*," May 9, 1879, p. 13.
Firmenich . . . . . * "*Am. Man.*," May 2, 1879, p. 16.
Firmenich . . . . . * "*Iron Age*," xxi., June 6, p. 44.
* "*Scientific Amer.*," xxxviii. 398.
Hind . . . . . * "*Scientific American*," xl. 358.
Lawson . . . . . * "*Scientific American*," xliii. 4.
Meunier, Fr. . . . . * "*Engineering*," xxv. 493.
Ogle & Burnett . . . * "*Scientific American*," xlii. 178.
Root . . . . . * "*Engineer*," xli. 351.
"Rover," Br. . . . . * "*Engineering*," xxi. 245.
Thomas-Laurens, Fr. * "*Scientific American*," xl. 66.
Smeaton (1765) . . * "*Engineer*," xlvii. 459.
Circula., *Chambers*, Br. * "*Engineer*," xli. 226.
Experi., Franklin Inst. "*Manufact. & Builder*," xii. 274.
Exp., Manchester, Br. * "*Engineering*," xxi. 236.
Furnace, "Economy."
Smith . . . . . * "*Iron Age*," xx., July 19, p. 1.
Lancashire, *Live*t, Br. * "*Engineer*," xlix. 387.
Steam boilers, priming of.
Major . . . . . * "*Scientific American Sup.*," 1299.
Steam boiler, sectional,
Tests, *Howard* . . . * "*Van Nostrand's Mag.*," xiv. 166.
Kelly . . . . . * "*Engineer*," xlii. 198-206.

Anderson, * *Firmenich*, *
Babcock & Wilcox, * *Harrison*, *
"Exeter." * *Reed*. *

Tubular.
Babcock & Wilcox . * "*Scientific American Sup.*," 483.
With *Ten-Brink's* grate.
Escher, Wyse & Co. Switz. . . . . * "*Engineer*," xlvi. 5.
High pressure, *Hawksley, Welch & Co.*, Br. * "*Engineering*," xxvi. 519.
Lancashire . . . . "*VanNostrand's Mag.*" xv. 210.
Galloway . . . . * "*Scientific American Sup.*," 449.
Exeter machine works * "*Scientific American Sup.*," 738.
Expe., Manchester, Br. * "*Engineer*," xli. 216.
"Elephant," Engl. . * "*Scientific American Sup.*," 2302.
Feed water heater.
Iron Clad Man. Co. * "*Manufact. & Builder*," ix. 265.
Feeder, *Bergstrom* . * "*Scientific American*," xlii. 386.
House of Corliss engine, Centennial . * "*Scientific American Sup.*," 213.
Marine vertical, S. S. "Vera Cruz" . . . * "*Engineer*," xlii. 273, 276.
Reversible, *Vail* . . . * "*Scientific American Sup.*," 57.
Sectional, *Root* . . . * "*Engineering*," xxx. 266.
Davies, Br. . . . . * "*Engineering*," xxiv. 122, 127.
Staffordshire, Br. . . * "*Engineer*, l. 327.
Setting, for plantation sugar houses, *Cort* . * "*Scientific Amer.*," xxxviii 388.
With *Ten-brink* fire-grate, Switz. . . . * "*Engineering*," xxvii. 437
Test, Manchester, Engl. * "*Scientific Amer. Sup.*," 1170.
Vertical, *Barron*, Br. . * "*Engineer*," xlii. 321.
Allison, Br. . . . . * "*Engineering*," xxiv. 126.
Allison . . . . . * "*Scientific Amer.*," xxxvii. 194.

Steam boiler. See VERTICAL STEAM BOILER.

Steam Boilers, *Mulhaise*. * "*Scientific Amer. Sup.*," 1202.
Philadelphia, 1800 . . * "*Scientific American Sup.*," 706.
Havemeyer sugar-works . . . . . * "*Scientific Amer. Sup.*," 1215.
Crown Point, N. Y. . * "*Engineering*," xxv. 217.
At Centennial. . . . * "*Scientific American Sup.*," 703.
Philadelphia, 1876. . . "*Engineering*," xxii. 74.

Black & Rogers. *Lynde.*
Firmenich. * *W. D. Andrews & Co*
Harrison. * *Wiegand.*

Tubulous, *Babcock-Wilcox* . . . . . * "*Manufact. & Builder*," xii. 127.
Forced circulation (7 Figs.) . . . . . * "*Engineer*," xlvii. 219.
Société Alsacienne Mulhouse . . . . * "*Engineering*," xxi. 4, 21, 56.
Centennial . . . . * "*Scientific American Sup.*," 214.
At Centennial, tests . "*Scientific American Sup.*," 1409.
For water-works . . * "*Iron Age*," xxv., Feb. 5, p. 1.
Lonsdale, Br. . . . * "*Engineering*," xxii. 481.
Mechanical firing, which see.
Perkins . . . . . * "*Scientific American Sup.*," 1282.
Philadelphia, 1876 . * "*Engineering*," xxii. 103.

Babcock & Wilcox. * *Kelly.*
Exeter Machine Works.

SS. "City of San Francisco," *Roach* . . * "*Engineering*," xxiii. 268.
Relation of grate surface and heating surface . . . . . * "*Scientific Amer.*," xxxix. 224.
And engines, high pressure, on, *Perkins* . "*Van Nostr. Mag.*," xvii. 143.
Report of judges of Group XX., "*Centennial Exhibition Reports*," vol. vi., includes the following: —

Hoadley, (portable) . . . . . p. 155 *
Wiegand . . . . . p. 141, * 159
Harrison . . . . . p. 141, * 160
Firmenich . . . . . p. 141, * 161
Rogers & Black . . . . . p. 142, * 162
Andrews . . . . . p 142, * 163
Root . . . . . p. 142, * 164
Kelly . . . . . p. 143, * 165
"Exeter" . . . . . p. 143, * 166
Lowe . . . . . p. 143, * 167
Babcock & Wilcox . . . . . p. 144, * 168
Smith . . . . . p. 144, * 169
Galloway . . . . . p. 144, * 170
Anderson . . . . . p. 144, * 171
Pierce . . . . . p. 145, * 172

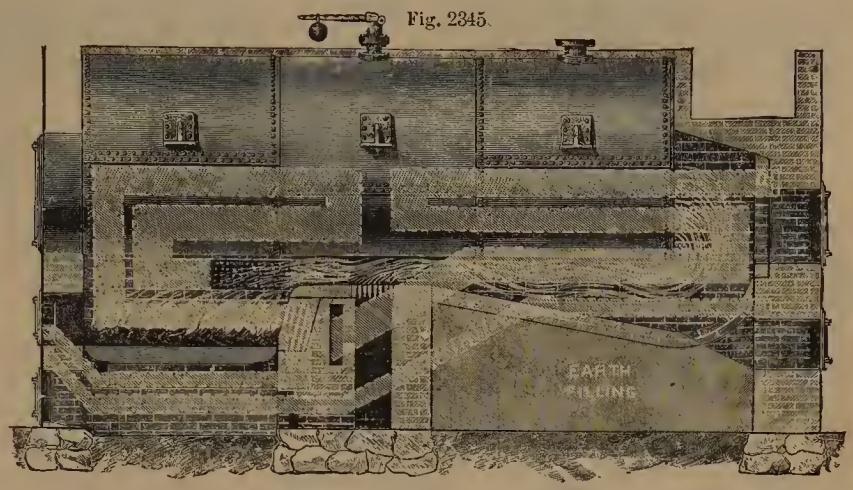
Steam boiler, horizontal.
Galloway, Gt. Br. . * *Thurston's* "*Vienna Rept.*," ii. 110.
Sect., *Howard*, Gt. Br. * *Thurston's* "*Vienna Rept.*," ii. 125.
Adamson, Gt. Br. . . * *Thurston's* "*Vienna Rept.*," ii. 127.
Vertical, *Davey-Paxman*, Gt. Br. . . . * *Thurston's* "*Vienna Rept.*," ii. 127.
Sectional, *Belleville*, Fr. * *Thurston's* "*Vienna Rept.*," ii. 131.
Two upright shells.
Meyer, Ger. . . . * *Thurston's* "*Vienna Rept.*," ii. 130.
Ehrhardt, Ger. . . . * *Thurston's* "*Vienna Rept.*," ii. 132.
Julius Bergman, Ger. * *Thurston's* "*Vienna Rept.*," ii. 132.
Tubular, *Paucksch & Freund*, Ger. . . . * *Thurston's* "*Vienna Rept.*," ii. 133.
Sigl., Austria . . . * *Thurston's* "*Vienna Rept.*," ii. 133.
Bolzano, Tedesco & Co., Austria . . . * *Thurston's* "*Vienna Rept.*," ii. 133.

Steam Boil'er Clean'er. The Hotchkiss boiler cleaner is composed of five principal parts: the reservoir, funnel, up-flow pipe, return pipe, and blow-off pipe; automatic in its action.

The funnel is partly submerged in such position that its opening intercepts the current of hot water flowing towards it. By the action of gravity in water of varying temperatures aided by the pressure on the surface, the hot surface water that enters the funnel flows into the reservoir through the up-flow pipe, displacing constantly an equal quantity of the cooler water therein, which flows back to the boiler.

Purves' automatic boiler cleaner draws impurities from the surface of the water through an automatic skimmer, from which they are passed on into the top chamber, which is constructed with deflecting plates, causing the impurities to fall into the lower chamber, while the pure water passes through a pipe into the lower part of the boiler.

Fig. 2345.



Steam Boiler Furnace.

Steam Boil'er Feed'er. Pratt's boiler feeder is also a return steam trap with an automatic device, that drains the water of condensation from heating coils, and returns the same to the boilers, thus doing away with pumps or other mechanical devices for such purpose.

Steam Boil'er Feed'-wa'ter Heat'er. Strong's feed-water heater and filter is a device that in connection between the feed-water and the boiler raises the temperature of the water and cleanses it of impurities.

Steam Boil'er Fur'nace. The heating chamber that is generally placed beneath or inside of a steam boiler. There are various plans of construction in accordance with the description of fuel to be used, the consumption of the gas escaping therefrom, the plan of the boiler with which it is connected, etc.

It is claimed that the fuel of the future will in a great measure he gas, generated by the furnace that then utilizes it not only in the generation of steam, but also in the production of a future supply of gas itself.

The great advance made in the manufacture of steel is due in a great measure to the use of hot air, and to-day steel is manufactured cheaper than iron in the Siemens' gas regenerative furnace.

In the old style iron furnaces only a small per cent. of the power of coal was realized. The giant power was unhound, let loose, and after doing but a small percentage of the work it was capable of performing, escaped for parts unknown.

It is claimed that the Siemens' system has so improved the combustion of fuel that it now realizes 20 per cent. of the units of heat contained in coal, a saving of 40 or 50 per cent. in fuel over the old way. In this furnace coal is burned in a retort, and the smoke and gases (carbonic oxide) are carried up a large vertical tuhe from 12′ to 15′, after which it proceeds horizontally any required distance, and then descends to the heat regenerator, through which it passes before entering the furnaces. Two generators are used on each side, the gas ascending through one, while pure atmospheric air intensely heated hy its passage through the regenerator, ascends through the neighhering passage, and both are conducted through passage outlets, at one end of the furnace, where mingling they burn, producing the heat due to their chemical action.

Smith's smoke-consuming furnace (see "*Mech Dict.*," p. 2330) has a further improvement in its adjustable arrangement; the grate being elevated or depressed, so as to increase or diminish the distance between the fire and the bottom of the boiler at pleasure.

The grate consists of a series of bars, supported by a frame that rests upon a standard which slides in a hollow post, that is slotted on one side to admit the end of a lever which sets into a recess in the standard, and elevates or depresses the same. The lever is pivoted in the upper end of another standard, forming a fulcrum, and is provided with a handle by means of which it is operated. The lever has an attachment by which it can be fastened to hold the grate in any fixed position. There are coluuns or heaters on the sides of the boiler that take the place of the brick walls, and being always filled with water get the benefit of the heat that would have been absorbed by the brick walls. The bridge wall is hollow and always filled with water and is connected with the main boiler.

The Jarvis furnace, Fig. 2345, has a unique feature in its setting whereby air is admitted by small flues in the front, and then conducted through a number of horizontal expanding duets, in which it traverses forward and backward, until finally in a heated state it enters by the furnace bridge wall and other places, uniting with the products of combustion and causing consumption of the gases. By the arrangement of this furnace it is claimed that all kinds of cheap fuel can be used without a blower. Seeing that it is generally admitted that perfect combustion of fuel does not take place till the gases are fully generated, it follows that gas fuel is one of our first necessities. To get this it requires in the fuel about 40 per cent. of moisture to generate hydrogen, and then utilize the gas with hot air (oxygen), thus giving a hydro-oxygen or compound blow-pipe flame.

In carrying out the idea of the necessity of hydrogen, a wet screening mixture is used in the Jarvis furnace to produce a gas flame.

Steam Cap'stan. (*Nautical.*) A capstan intended for use on steamboats, operated through its connections with the steam power on board,

Steam Car'riage. A form of carriage like the ordinary road carriage, but having steam motive power.

Steam carriage, *Lauck* . * "*Scientific American.*" xxxvi. 57.
Steam carriages . . . "*Scientific Amer.*," xxxiv. 383.

Steam Carv'ing Ta'ble. A table heated by steam for keeping fowl, fish, or meat warm, previous to and during the process of carving.

Steam Crane.

Steam crane, portable.
Grieve . . . . . * "*Engineer*," l. 477.
Russell, Br. . . . . * "*Engineering*," xxix. 63.
Radiating, *Coode*, Br. . . * "*Engineer*," xliii. 341.
Traveling, *Smith*, Br. . . * "*Engineer*," xliii. 182.
With self-acting bucket.
Priestman, Br. . . . * "*Engineering*," xxviii. 129.
Steam-cutter engines and boilers, Washington navy yard . . . . . * "*Engineering*," xxi. 508.
Steam cultivator, *Barford & Perkins*, Br. . . . * "*Engineer*," xlvi. 19.
Steam cutter engine, U. S.
Loring . . . . . * "*Engineering*," xxii. 76.

Steam Dry'ing Ap'pa-ra'tus. Drying rooms and houses for seasoning timber, drying purposes in laundries, etc., through the radiating heat engendered by coils of steam pipes.

Steam En'gine. The first steam engine, — the Æolipile of Hero, 150 B. C., — is described in "*Mech. Dict.*," p. 2334, and the subsequent attempts to utilize this powerful agent.

The Westinghouse engine (see Fig. 2346) has the cylinders cast in one piece with the valve chamber, and bolted to the top of the bed-case. The cylinder heads cover the upper ends of the cylinders only, the lower ends being uncovered and opening directly into the chamber of the bed or crank-case. The pistons are of the trunk form, double walled at

the top to prevent condensation, open at the bottom, and carrying the wrist pin. The annular exhaust is a narrow belt surrounding the cyliuder, openiug into it by the ports, and communicating directly with the exhaust outlet. The position of the annular exhaust is such that the ports are uncovered by the piston just before the completiou of the stroke. The crauks balanced by the bobs, the crank-pin and the crank-shaft, are all of steel, and may be removed by taking off the crank case-head. The crank-shaft bearings, in the form of removable shells, are lined with babbitt metal.

Dr. Engel, director of the Prussian statistieal bureau, gives the following figures : —

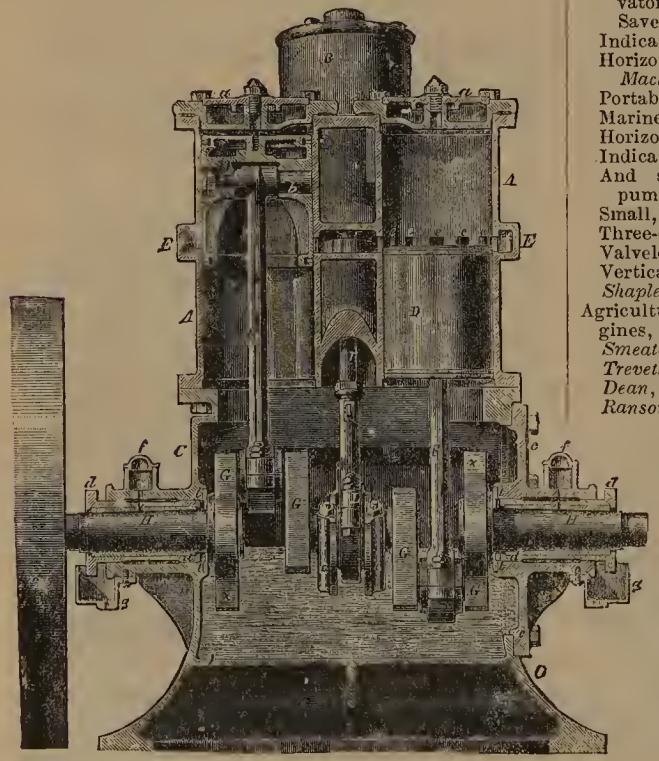
	Year.	No. of Locomotives.	No. of Stationary Engines.	Horse Power.	Ocean Steamers.	Tonnage.
United States	1873	14,223	40,191	1,215,711	3,061	2,624,431
Great Britain	1872	10,933	40,000	956.405	403	483,040
Germany	1871	5,927	–	–	225	171,039
Russia	1873	2,684	–	–	–	–
Austria	1873	2,369	–	–	–	–
Hungary	1869	506	–	–	–	–
France	1869	4,933	27,141	325,507	–	–
East Indies	1872	1,323	–	–	–	–
Italy	1872	1,172	–	–	–	–
Holland	1872	331	–	–	–	–
Belgium	1870	371	–	–	–	–
Switzerland	1868	225	–	–	–	–
Egypt	1870	212	–	–	–	–
Sweden	1872	185	–	–	–	–
Denmark	1865	39	–	–	–	–
Norway	1871	34	–	–	–	–
Total		45,467 = 10,060,000 h. p.				

Report of *Chas. E. Emery*, "*Centennial Exhibition Reports*," vol. vi., Group XX., p. 97, *et seq.*, includes —

Corliss, beam . . . . . * p. 97
Wheelock, horizontal . . . . . * p. 101
"Buckeye," horizontal . . . . . * p. 104
Launch, vertical . . . . . * p. 107
Dudgeon, rotary . . . . . * p. 108
Thompson, indicator . . . . . * p. 112
Edson, recording gage . . . . . * p. 113

Steam engine, *Tyson* . * "*Am. Man*," Aug. 1, 1879, p. 8.
Corliss . . . . * "*Scientific Amer.*," xxxiv. 351.
"Corliss" . . . . * "*Scientific American Sup.*," 561.
De Caus . . . . "*Scientific Amer.*," xxxvi. 208.
Ericsson's contribu. to "*Scientific American Sup.*," 105
Harris-Corliss . . . * "*Scientific American*," xxxv. 95.
Head "Prime mover" * "*Engineer*," xli. 210, 212.
"Little Giant," *Snyder* * "*Iron Age*," xx., Oct. 4, p. 1.
Maxim . . . . . * "*Scientific Amer.*," xxxiv. 287.

Fig. 2346.



Westinghouse Steam Engine.

Newcomen . . . . * "*Engineer*," xlvii. 403, 412, 430.
Smeaton-Newcomen.
Newcomen, 1712 (old priut) . . . . . * "*Engineer*," xlviii. 400.
Niles . . . . . * "*Min. & Sc. Press*," xxxviii. 65.
Snyder . . . . . * "*Min. & Sc. Press*," xxxv. 321.
Symington . . . . * "*Engineering*," xxiii. 64.
Symington (1788) . . * "*Engineer*," xlii. 1.
Trevethick (1811) . . * "*Engineer*," xlvii. 448.

Steam Engine. See BELLOWS' STEAM ENGINE.

Steam engines, Centennial stationary . . . "*Iron Age*," xviii., Oct. 12, p. 3.
Ervien. *Snyder.*
Lovegrove. *Wells.*

Steam engine, eompound * "*Scientific American Sup.*," 438.
Experimental.
Liége School of Music * "*Engineering*," xxx. 517.
Frame, *Finney* . . . * "*Scientific American Sup.*," 89.
Headless cyl., *Smith* * "*Scientific American*," xxxv. 198.
Hist. of the water elevators, Worcester, Savery, Pulsometer "*Scientific American Sup.*," 1821.
Indicator, *Prof. Sweet* * "*Iron Age*," xxi., June 20, p. 1.
Horizontal, *Putnam Machine Co.* . . . "*Scientific American*," xxxv. 351.
Portable, *Armitage* . * "*Scientific American Sup.*," 772.
Marine, *Cramp* . . * "*Scientific American Sup.*," 463.
Horizontal, *Niles* . . * "*Scientific American*," xxxv. 370.
Indicator, *Sweet* . . * "*Engineering*," xxviii. 117.
And street vacuum pump, *Gleason* . * "*Scientific American Sup.*," 488.
Small, *Tyson* . . . * "*Engineer*," xlix. 279.
Three-eyl., *Brotherhood* * "*Scientific American Sup.*," 538.
Valveless . . . . . "*Scientific American Sup.*," 497.
Vertical, *Niles* . . . * "*Scientific American*," xxxv. 370.
Shapley . . . . . * "*Scientific American Sup.*," 482.

Agricultural steam engines, notes ou early . "*Engineering*," xxvii. 543.
Smeaton, 1765 . . * "*Engineering*," xxvii. 548.
Trevethick, 1811 . . * "*Engineering*," xxvii. 548.
Dean, 1844 . . . . * "*Engineering*," xxvii. 548.
Ransome, 1841 . . * "*Engineering*," xxvii. 549.
Tuxford, 1842. * "*Engineering*," xxvii. 549.
Cambridge, 1847. * "*Engineering*," xxvii. 549.
Willis, 1849 * "*Engineering*," xxvii. 558.
Clayton & Shuttleworth, 1853. "*Engineering*," xxvii. 560, 572.

Steam engines, early, in America. * "*Engineering*," xxii. 383.

Turnbull's "A Treatise on the Compound Engine."
Bourne's "Catechism of the Steam Engine."
Bourne's "Handbook on the Steam Engine."
Bourne's "Treatise on the Steam Engine."
Rankine's "The Steam Engine."
King's "Notes on Steam."
Auchincloss' "Link and Valve Motions."
Bacon's "Steam Engine Indicator."
Isherwood's "Engineering Precedents."
MacCone, "Slide Valve Eccentrics."

Stillman's "Steam Engine Indicator."
Porter's "Steam Engine Indicator."
See *Burgh's "Practical Illustration of Land and Marine Engines."*
Burgh's "Practical Rules for the Perfecting of Modern Engines and Boilers."
Burgh's "Slide Valve."
Burgh's "Modern Marine Engineering."
Main and Brown's "Marine Steam Engine."
Colburn's "The Locomotive Engine."
Templeton's "The Practical Examinator on Steam and the Steam Engine."
Forney's "Catechism of the Locomotive."
Mallet's "Compound Engines," from the Freuch.

Steam, Gas, and Air En'gines. See under the following heads: —

Aëro steam engine.
Agrieultural engine.
Air bridge.
Air cock.
Air engine.
Air motor for cars.
Alarm whistle.
Ammoniacal gas engine.
Ammonia engine.
Angular safcty valve.
Annular piston engine.
Anti-clinker grate.
Anti-incrustator.
Arch bar.
Atmospheric engine.
Atmospheric-gas engine.
Automatic cut-off engine.
Automatie steam engiue.
Back cylinder head.
Baffle plate.
Balance engine.
Bar.
Beam engine.
Bellows steam engine.
Boiler.
Boiler covering.
Boiler feeder.
Boiler feed regulator.
Boilcr ferrule.
Boiler fittings.
Boiler flue.
Boiler lining.
Boiler tube.
Boiler-tube cleaner.
Boiler washing apparatus.
Box engine.
Calking.
Caloric engine.
Circular slide valve.
Circulating boiler.
Circulating drum.
Circulating generator.
Circulating steam boiler.
Circulating tube.
Coal-dust-burning grate.
Coal dust furnace.
Coil steam boiler.
Compound beam engine.
Compound steam boiler.
Compound steam engine.
Compressed air engine.
Compressed hot-air eugine.
Compression engine.
Condenser.
Condensing apparatus.
Condensing engine.
Controlling valve.
Corliss engine.
Cornish boiler.
Coupled steam engine.
Crank-pin cup.
Cross head.
Cross-tube boiler.
Cut-off.
Cylinder cock.
Cylinder lubricator.
Damper.
Damper regulator.
Demi-fué.
Diminishing valve.
Direct acting steam engine.
Disk engine.
Double-lip safety valve.
Double piston engine.
Double safety-valve.
Draft regulator.
Drop cut-off.
Dumping grate.
Easing valve.
Eccentric valve.
Economizer.
Egg-end steam boiler.
Electro-capillary motor.
Engine regulator.
Equilibrium cock.
Equilibrium valve.
Exhaust chamber.
Exhaust nozzle.
Expansion steam engine.
Expansion valve.
Expansion valve gear.
Farm locomotive.
Feed pump regulator.
Feed-water apparatus.
Feed-water cleauer.
Feed-water heater.
Feed-water regulator.
Ferrule.
Fire engine.
Fire regulator.
Flue.
Flue boiler.
Front eylinder head.
Fuel economizer.
Fuel feeding apparatus.
Furnace feeder.
Furnace regulator.
Fusible plug.
Gas and steam motor.
Gas boiler.
Gas engine.
Gas machine.
Gas, steam, and air engine.
Globe oil-cup.
Globe safety-valve.
Goveruor.
Goveruor valve.
Greaser.
Hanging leg boiler.
Hanging tube boiler.
Horizontal steam engine.
Hot air engine.
Hot air pumping eugine.
Il-piece.
Hydraulic engine.
Hydro-carbon engine.
Hydromotor.
Inspirator.
Inverted steam engine.
Lancashire boiler.
Launch engine.
Launch steam engine.
Lever and cam valve.
Lime catcher.
Lime extractor.
Lock-up safety valve.
Low water alarm.
Low water detector.
Low water valve.
Lubricator.
Lubricator alarm signal.
Lubricator cup.
Marine boiler.
Marine engine.
Marine tubular boiler.
Marine whistle.
Mechanical stoker.
Mercurial safety valve.
Metallic packing.
Mining engine.
Multicylinder engine.
Multiflue steam boiler.
Multitubular boiler.
Needle lubricator.
Offset glass.
Oil cup.
Oil engine.
Oiler.
Oleojector.
Oscillating cylinder engine.
Oscillating paddle eugine.
Oscillating steam engine.
Over-pressure valve.
Packing.
Packing expander.
Packing gland.
Packing leather.
Petroleum engine.
Pile driving engiue.
Piston packing.
Piston packing expauder.
Piston-rod packing.
Piston spring.
Piston valve.
Plowing engine.
Portable steam engine.
Relief valve.
Reversible steam boiler.
Reversiug and expansion gear.
Reversing eugine.
Reversing gear.
Revolving boiler steam engine.
Road locomotive.
Road roller.
Road steamer.
Rotary steam engine.
Rotary tubular boiler.
Rubber packing ring.
Safcty cock.
Safety cylinder cock.
Safety disk.
Safety valve.
Screw engine.
Screw-propeller engine.
Sectional steam boiler.
Sectional ring boiler.
Semi-fixed.
Semi-multiflue boiler.
Semi-multitubular boiler.
Semi-rotary engine.
Semi-tubular boiler.
Siphon condenser.
Six-cylinder steam engine.
Slide cut-off.
Slide-lubricator.
Slide valve.
Slide-valve oiler.
Smoke-burning furnace.
Smoke consumer.
Smoke preventive.
Solar boiler.
Solar-caloric engine.
Spiral tube boiler.
Speed recorder.
Spray condenser.
Sput.
Steam boiler.
Steam boiler covering.
Steam boiler feeder.
Steam boiler furuace.
Steam carriage.
Steam engine.
Steam engine governor.
Steamer.
Steam fire engine.
Steam gage.
Steam greaser.
Steam hammer.
Steam indicator.
Steam machiuery.
Steam motor.
Steam packing.
Steam-pipe covering.
Steam piston.
Steam power.
Steam pressure recorder and high pressure alarm.
Steam pressure regulator.
Steam stamp.
Steam stoker.
Steam trap.
Steam valve.
Steam wheel.
Stoker.
Stoker, mechanical
Straw-burning engine
Suct lubricator.
Surface condenser.
Tallow eock.
Tallow cup.
Tallow lubricator.
Tank eugine.
Three cylinder steam engine.
Tire.
Traction engine.
Tramway eugiue.
Trip cut-off.
Triple cyliuder steam engine.
Triple cylinder compound steam engine.
Trunk engine.
Tube eleaner.
Tube scraper.
Tubulous boiler.
Twin-cylinder steam engine.
Two-piston steam engine.
Underground running engine.
Unit area safety valve.
Up-take.
Valve gear.
Valveless engine.
Variable cut-off steam engine.
Variable exhaust steam engine.
Variable expansion gear.
Variable expansion steam engine.
Velometer.
Vertical steam boiler.
Vertical multiflue boiler.
Vertical steam engine.
Vertical tubular boiler.
Wagon.
Wall steam engine.
Water eugine.
Water gage.

Steam En'gine In'di-ca'tor. An instrument for recording the pressure of steam at any point of the motion of the piston.

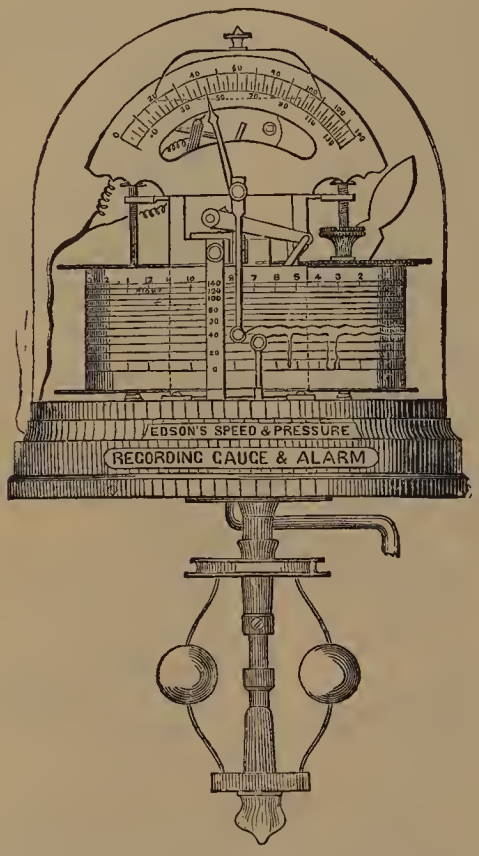
Steam Flour Core. This term is applied to dry-sand cores in which the flour has been steamed before it is mixed with the sand. What is meant by steamed flour is flour that has been mixed with water into paste and boiled with a jet of steam turned into it from the boiler.

Steam Gage. An attachment to the boiler to indicate the pressure of steam. See *"Mech. Dict.,"* p. 2344.

The apparatus shown iu Figs. 2347 and 2348 represents Edson's recording steam gage and speed recorder.

The mechanism of the instrument is first, a train of clockwork which controls the motion of a cylinder covered with a strip of paper, a pencil-arm with a pencil bearing on the paper, and a steel diaphragm of peculiar construction by which, through the details shown, the pencil is worked. This is in brief the construction of the steam gage. The speed-recording apparatus is similar, except that it has a governor driven by a belt from any principal part, and shows the fluctuations from a regular velocity on the same chart as the steam gage. This through the pencil attached to what is in ordinary governors the thrust collar communicating with the throttle-valve. So soon as the engine or train, if the ma-

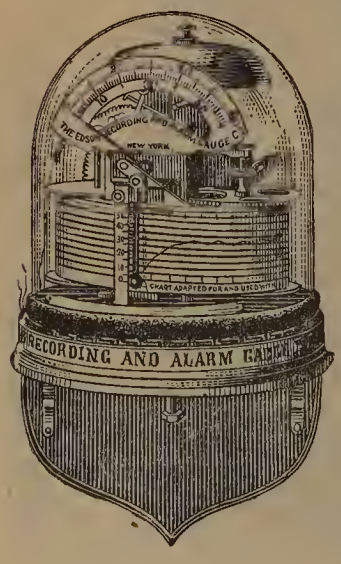
Fig. 2347.



Combined Speed and Pressure Recording Gage and Alarm.

chine is attached to a locomotive, is started, the governor is put in motion and the pencil connected with the paper cylinder. If the speed is uniform the line drawn on the cylinder is straight or nearly so, but any diminution in speed, any stoppage from any cause, is detected at once by the nature of the diagram. If the speed is slower than schedule time, the instrument shows it by fluctuations, or speed-curves in the horizontal line. As will be readily seen, any stoppage outright is shown by the instrument in the form of a loop. This, of course, from the reason that when the train stops the instrument stops, but the paper cylinder goes on tracing a horizontal line, the length of the base of which, or the area of the loop, indicates the time lost by stopping. The place stopped at is also shown, for as all stations can be marked on the paper on the cylinder, any loop occurring between stations shows a stop at once. This record, in connection with the steam card from the gage, forms a very complete diary of the working of the train it may be applied to, and is entirely removed from external interference or being tampered with by interested parties by surrounding it with a glass dome, fitted with a lock.

Fig. 2348.



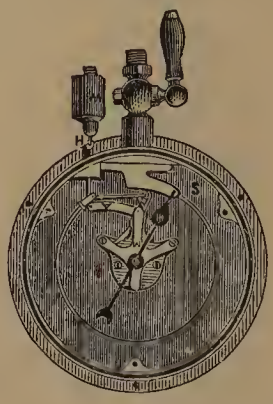
Steam Gage.

Similarly in regard to the gage recording the steam pressure — its construction and operation are as follows: the readings are obtained from the dial by an index and pointer as usual, operated by a corrugated steel diaphragm of peculiar construction in some respects. Instead of a small disk, such as is commonly used for this purpose, Mr. Edson employs a very large one. The object of this is to equalize the action of the diaphragm and render it more sensitive and even. With the construction of diaphragm, as shown by the dotted lines in the engraving, the elasticity is greatly increased, and the dial indications, as well as the records of pressure, are peculiar to each intrument.

Besides these features there is an electric bell at the back of the instrument which by a simple and obvious arrangement opens and closes the circuit at any desired pressure, giving instantaneous warning of high or low pressures as required.

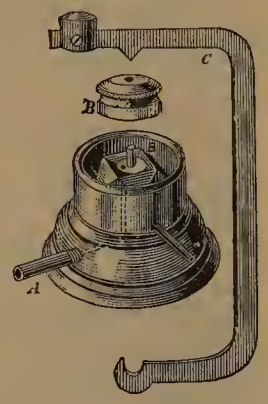
Ashcroft's "bourdon" steam gage, Fig. 2349, is provided with an elastic ring that prevents moisture caused by steam from gage-cocks entering the interior of the gage and corroding the movement.

Fig. 2349.



Steam Gage.

Fig. 2350.



Steam Gage Tester.

Steam Gage Test'er. An instrument to test the accuracy of the steam gage. See Fig. 2350.

The apparatus consists of a brass base, provided with a pipe, *A*, to be connected with a pump. At *B* is a hardened steel valve and seat, the latter having knife edges for the valve to rest upon, and being made exactly one square inch in area. The valve is guided by a guide-stem in the seat. The water-pipe *A* opens directly under the valve, as shown by the dotted lines. The valve, when in place, makes a tight joint with the knife edges, and the pressure beneath is confined until it exactly balances the combined weight of the valve yoke *C* (which rests by a pointed projection on the valve), and any extra weight which may be suspended from the lower hook of the yoke. With this the accuracy of a gage, at any specified point of its registry, can be ascertained.

Steam Greas'er. An impermeator to deliver the lubricant into the current of the steam, which it impermeates, being carried into the interior parts of the engine in minute globules.

Steam Ham'mer. One operated by steam; technically one in which the hammer reciprocates in guides, the shaft being usually in line with the engine piston, — the piston-rod, in fact, forming the hammer rod.

The steam hammer is usually vertical.

Plate XLVI. shows the immense 80-ton steam hammer of Schneider & Co., Creusot, France. This hammer was finished in 1877 and represented by wooden model of the exact proportions at the Paris Exposition of 1878. This hammer is the largest in the world, and is said to possess more than three times the power of the 50-ton Krupp hammer at Essen. A 100-ton forging may be readily turned upon its anvil by means of four powerful cranes.

The cost was $500,000, including its accessories and the building in which it works.

Machinery is now required to deal with immense masses. Witness the 100-ton Italian cannon for the "Duilio" and sister ship; the Siemens-Martin steel ingot of 120 metric tons, cast at Creusot; a rolled armor plate 13′ 10″ × 8′ 5″, 2′ 7″ thick, weighing 65 metric tons, and exhibited at Paris, 1878. One plate train of the Terre Noire works will roll an armor plate 36.08′ long, 8.2′ wide, and 3.9′ thick.

The hammer made by Ramsbottom, of England, is an innovation upon the usual method.

Instead of a vertical hammer, it consists of two immense masses of iron forming the hammers, which are mounted on carriages sustained by small, strong, friction-wheels, and move toward or separate from each other by moving horizontally on rails. Between them is the anvil, which merely takes the weight of the piece to be worked, while it is struck simul-

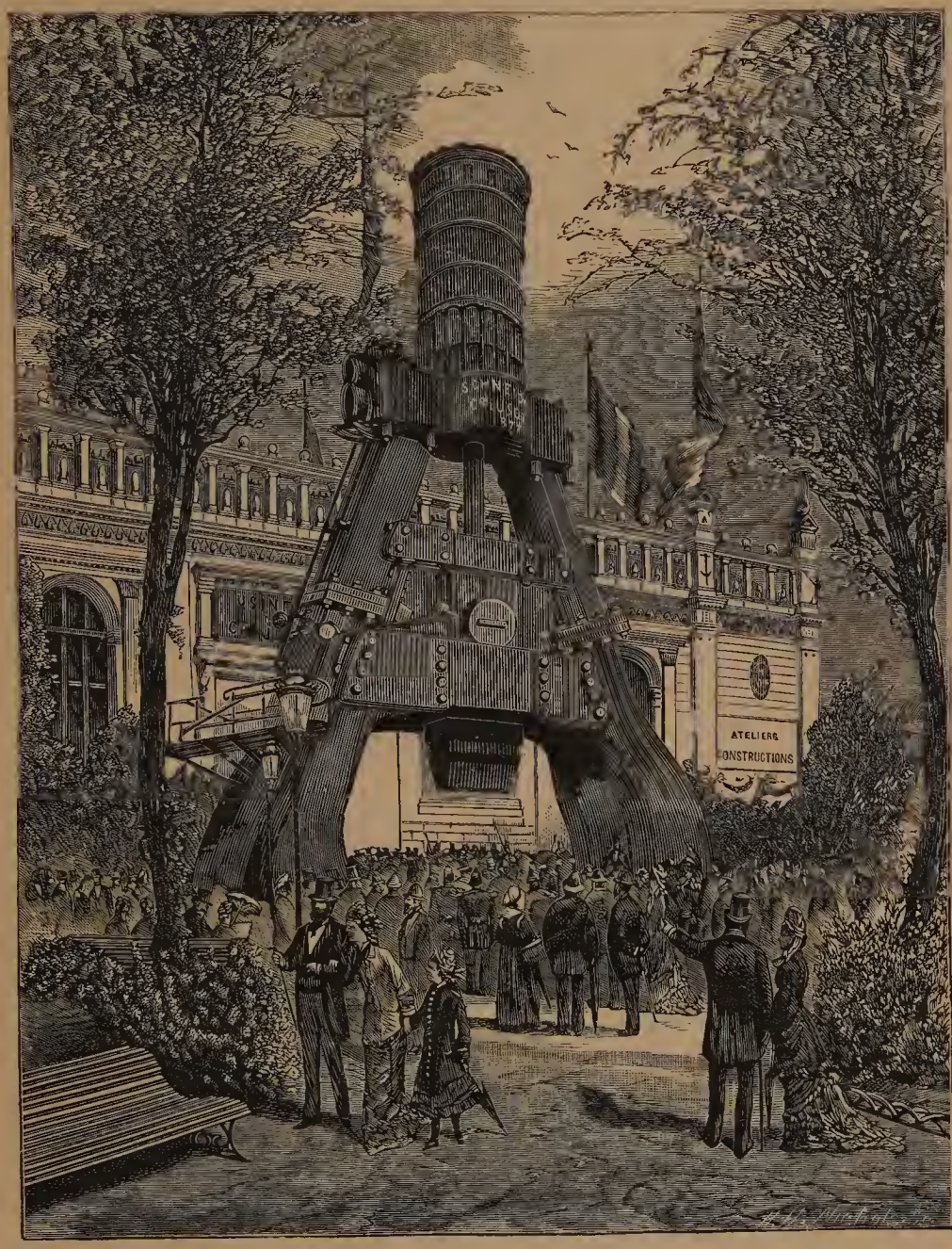
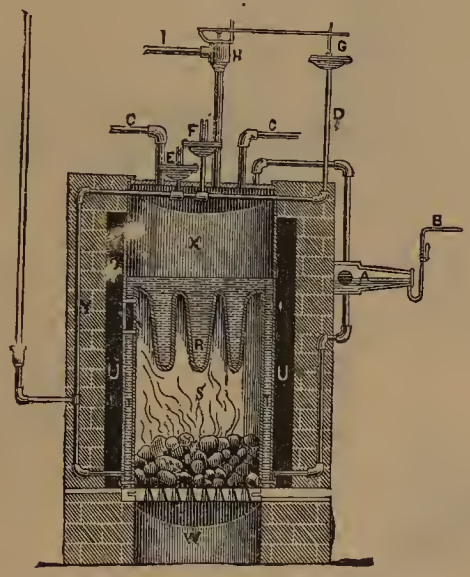


PLATE XLVI. EIGHTY-TON STEAM HAMMER. (SCHNEIDER & CO., CREUSOT, FRANCE.) *See page* 860.

taneously hy the two hammers which approach it from either side. The hammers are driven hy large steam pistons, which are, in this case, set below the floor and under the anvil. This hammer requires no such foundation as is needed hy the usual form of steam-hammer, and it possesses the apparently generally unrecognized, but nevertheless important, advantage, that none of the energy of the hlow is misapplied to the shaking of the earth and the injury of the buildings; it is all usefully applied to the shaping of the work. For many kinds of work this hammer has suen decided advantages over the standard forms that it seems surprising that it has not become more widely known and more generally introduced. Three of these hammers are in use at Crewe, England.

Steam Heat'er. Warner's heater, Fig. 2351, is a low pressure steam-heating apparatus, with the hydrostatic or open column connected with the boiler at the bottom, standing at its side to such a height as to allow a pressure of only two pounds of steam to be generated.

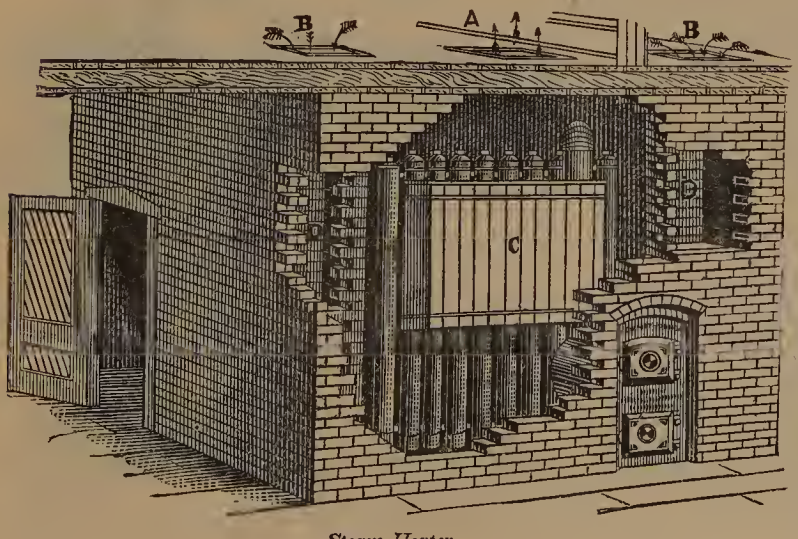
Fig. 2351.



Steam Heater.

In Camphell & Pryor's method of steam heating for dwellings, the steam hoiler and radiators are inclosed in a heating room in the cellar, doing away with pipes and radiators in the living rooms, the heat ascending through ordinary registers, while the eold air is drawn off the floors down flues leading to the hottom of the heating-room. Fig. 2352 shows the heating room, hot and eold air registers, and a hot-water hattery, used without the steam boiler. The arrows at *A* show the direction of the eurrent of warm air; *B B*, currents of cold air passing off the floor, down flues *D* to near the bottom of the heating room. The water battery, *C*, is a series of conneeted pipes holding 50 to 100 gallons of water, having a gas-pipe attached and passed around the heating bowl of the stove. When the fire is the warmest this water beeomes heated to nearly boiling, giving out its heat again at any time the fire should slacken. By uncovering these water pipes the air may be moistened to any degree desired. A small pipe leads from the bottom of the heating room into the smoke flue to carry off the foul air that may accumulate. The furnace is fed from outside of the heating room.

Fig. 2352.



Steam Heater.

This method is the invention of A. K. Campbell, Newton, Iowa, who claims that hy establishing a current of air through the house and heating chamber he equalizes the temperature of the living rooms so that the difference between the floor and ceiling of a room is only 6° to 10°, while with the ordinary method the thermometer will show a difference of from 30° to 50° between the temperature of the floor and ceiling. He does not warm the large current of outside air usually necessary to force the hot air up into a room already full of air. Fresh air in plenty, he claims, is supplied any house through the crevices of the doors and windows; but he uses a small side pipe, if requested.

Steam Heat'er for Steam Fire En'gines. A device for attachment to steam fire engines for heating the feed-water before its passage into the boiler.

Steam Me-tal'lic Pis'ton. A tight elastic piston with equal expansion, and a revolving tendency in the packing rings.

Steam Mo'tor. A small engine for household use, attachable by bracket to the wall, for running sewing and knitting machines, fans, churns, etc.

Steam motor, small . .	* "*Scientific American*," xliii. 390.
Davis	* "*Scientific American*," xliii. 278.
Mayhew	* "*Scientific American*," xliii. 66.
Tyran	* "*Scientific American*," xlii. 163.

Steam Nav'vy. A steam excavator.

Steam Pack'ing. Asbestos steam packing, intended to contend with high temperature, moisture, and friction.

Steam Pipe Cov-er'ing. The peculiarity of the Chalmers steam pipe covering consists in leaving an air space, or dead air chamber, of 1″ or more, between the covering and surface covered. This is obtained by taking heavy wire cloth, to which is fastened, every four or six inches, a stud one inch or more in length. The wire cloth is then placed over the surface to be covered, the studs keeping it off the necessary distance. A non-conducting composition is then applied from one half to one inch in thickness, which partly penetrates the meshes of the wire cloth and keys itself. The second coat gives a smooth finish.

Leroy's composition: Mix thoroughly 448 parts of a paste of clay, 80 parts of paper pulp, 10 parts zinc wool, 10 parts of hemp, 8 parts of eocoa-nut fiber, 55 parts of charcoal powder, 23 parts of sawdust, 8 parts of flour, and 22 parts of tar. Heat the mixture until it is uniformly pasty.

See also Steam Pipe Covering, "*Mech. Dict.*"

Steam Plow.

Dr. Knight's report on Class 76 at the Paris Exposition contains views and descriptions of the following engines, apparatus, and modes of installation. See "*Paris Exposition* (1878) *Reports*," vol. vi. pp. 53–89.

Double-engine steam-plowing tackle, *Fowler*, England.

Steam-plowing engine, *Fowler*, England.

Rope-porter, *Fowler*, England.

Locomotive for the double-engine system, *Aveling & Porter*, England.

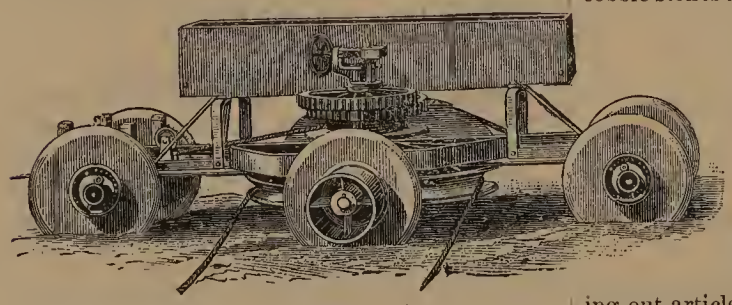
Farmer's engine for all purposes, *Howard*, Englaud.

Single-engine and headland-anchor plan of installation, *Howard*, England.
Engine with two winding-drums, *Fowler*, Englaud.
Movable headland anchor, *Fowler*, England.
Agricultural locomotive, *Aveling & Porter*, England.
Roundabout plan of installation, *Fowler*, England.
Windlass for the roundabout system, *Fowler*, England.
Anchor for the roundabout system, *Fowler*, England.
Portable engine and rear windlass for the roundabout system, *Howard*, England.
Roundabout system, with detached windlass, *Barford & Perkins*, England.
Roundabout system, engine, and windlass combined, *Barford & Perkins*, England.
Self-acting and self-moving anchor, *Barford & Perkins*, England.
Howard's roundabout tackle, *Eodin*, France.
Engine and windlass for roundabout system, *Debains*, Fr.
Installation of the roundabout system, *Debains*, France.
Six-furrow balance-plow, *Fowler*, England.
Three-furrow balance-plow, *Barford & Perkins*, England.
Plow and subsoiler, *Howard*, England.
Steam grubber, *Fowler*, England.
Double-actiou steam cultivator, *Howard*, England.
Turning cultivator, *Fowler*, England.
Turning harrow, *Fowler*, England.
Steam harrow, *Fowler*, England.
Combined harrow and seeder, *Fowler*, England.
Steam roller, *Fowler*, England.
Disking machine, *Fowler*, England.
Drainiug plow, *Fowler*, England.
Reclamation plow, *Fowler*, England.

Steam Plow Anchor.

Fig. 2353 shows Fowler's headland anchor, or rope carrier, which is moved along the headland by the motion of the pulley that is turned by the rope; the sheave is conuected by a gear to a drum, which winds up a rope stretched along the headland and keeps the anchor opposite its work.

Fig. 2353.



Steam Plow Anchor.

Steam Pres'sure Re-cord'er and High Pres'sure A'larm. See under STEAM GAGE, p. 859, *supra.*

Steam'-proof Ce-ment'. "*Dingler's Polytechnic Journal*" gives a description of the manufacture of a new steam-proof cement, discovered by Mr. A. C. Fox, which it is claimed is not affected by hot or cold water, nor by acids or alkalies. First, a chromium preparation is made in the following manner: 2.5 parts, by weight, of chromic acid are dissolved in a mixture of 15 parts of water and 15 parts of ammonia. To this solution about 10 drops of sulphuric acid, and, finally, 30 parts of sulphate of ammonia and 4 parts of fine white paper, are added When about to be used, gelatine dissolved in dilute acetic acid is added.

Steam Pump.

The large Blake mining pump has a double plunger, 16″ in diameter, and steam cylinder 28″ in diameter, with a stroke of 24″. This pump discharges 1,000 gallons per minute when running at the regular speed of 23 strokes per minute. These double plunger pumps are intended for mines and for pumping gritty water, they being very hard to wear out. The small cylinder surmounting the main cylinder contains an ordinary spring ring steam piston,—not a valve,—which is the motor for the main valve. The cylinder heads of both cylinders through which the piston passes are cast in one piece, with the connection between them, as in many other steam pumps. At each joint of the valve gearing there is a steel friction roller that can be renewed when worn.

In H. R. Worthington's duplex steam pump, the valve motion is the prominent and important peculiarity, as being that to which the pump owes its exemption from noise or concussive action. Two steam pumps are placed side by side, and so combined as to act reciprocally upon the steam valves of each other. The one piston acts to give steam to the other, after which it finishes its own stroke. and waits for its valve to be acted upon before it can renew its motion. This pause allows all the water valves to seat quietly, and removes everything like harshness of motion. As one or the other of the steam valves must be always open, there can be no center or dead point. The pump is, therefore, always ready to start when steam is admitted, and is managed by the simple opening and shutting of a valve.

The "Knowles" steam pump is a long, connected pump. In the steam chest there are only "two pieces," the valve (which is a flat slide valve) and the valve-driving piston, each being made all in one piece, thus giving only two moving pieces in the steam chest, to produce the entire motion. The steam valve of the pump, being an ordinary flat slide valve, does not have a rotary motion, but simply a horizontal motion, the same as any slide valve. This style of flat valve embodies the most favorable possible conditions for tightness, even after the wear consequent upon a long use. The slight rotary motion imparted to the valve-driving piston, by the rocker arm, simply puts it in a position to be driven horizontally by the steam, in which motion it carries the slide valve with it, the two being directly connected together. It has no springs, screws, yokes, nuts, followers, rings, plunger-cushion springs, movable seats, poppet valves, or studs, inside of the steam chest. The driving piston is entirely independent of exhaust steam for cushioning, thereby working with the same certainty and exactness when exhausting into vacuum (working condensing) as when exhausting into atmosphere. It will also work equally well in a vertical as in a horizontal position.

Steam Ram'mer. One designed to supersede hand-work in the paving of the streets of large cities, where extensive surfaces of stone blocks and cobble-stones are constantly requiring to be laid or repaired, and which can only be imperfectly put down by hand. The apparatus is operated on the principle of the trip-hammer; it can be speeded to strike fast or slow, and will deliver a blow of from 1 lb. up to 1,500.

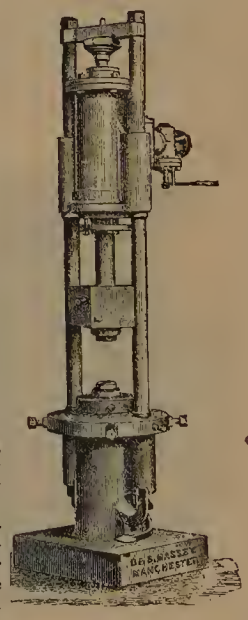
Steam Reap'er.

Aveling & Porter, * Knight's report "*Paris Exposition*," vol. v., p. 158.

Steam Stamp. One for stamping out articles from heavy sheet metal.

Fig. 2354 shows a 3-cwt. steam stamp, specially designed for forging articles of which large quantities are used, by means of dies cut to the form of the finished article. The stamp is not self acting, but is regulated either by the foot or by the hand. When left to itself with the steam turned on, it rises to the top of its stroke and remains in that position until the valve is brought down by the hand or foot of the attendant. It then delivers a single "dead-blow," and rises again, as before, leaving the lower die clear for the removal of the finished article and the introduction of the hot iron for a new one. The upper die is fixed rigidly in the tup or hammer-head, the lower one being adjusted by strong poppet-screws until it exactly coincides with it. The tup is fitted between slide-bars which guide it down upon the lower die, and, with a stamp of adequate size, the forging can be finished at a single blow with a great degree of accuracy. Special arrangements are introduced for facilitating the adjustment of the dies, for removing bolts and similar articles from the dies, for preventing the piston from striking the cylinder-cover, and for adjusting the slides so as to compensate for the wear caused by friction.

Fig. 2354.



Steam Stamp.

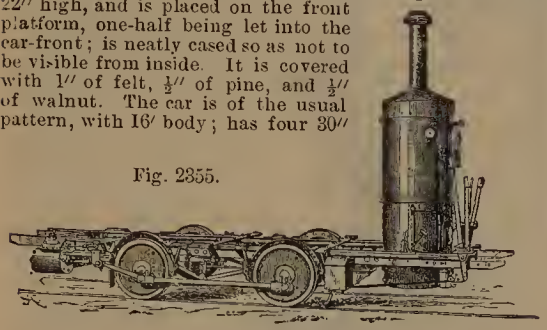
The 5 cwt. stamp will make a bolt $1\frac{1}{4}''$ diameter, with large square head $2\frac{3}{4}''$ diameter and $1''$ thick, and with very deep square neck, at a single blow.

The principal sizes of these stamps weigh from $\frac{1}{2}$ to 10 cwt.

Steam Street Car. Fig. 2355 shows the operating part of the Baldwin steam street car.

Two $6'' \times 10''$ cylinders are attached to an inverted cast-iron bed-plate, bolted to the car-bottom near the center-line and in front of the rear axle. The cranks are on the front axle, which has both inside and outside bearings. The jaws for the inside bearings are cast on this bed-plate. The valve-gear is the usual shifting link. The exhaust is carried through a system of pipes, so that it is partly condensed before escaping, and is nearly noiseless. The boiler is vertical, $72'' \times 30''$ and $\frac{1}{4}''$ steel, with tubes $48'' \times 1\frac{1}{2}''$, and fire-box $22''$ high, and is placed on the front platform, one-half being let into the car-front; is neatly cased so as not to be visible from inside. It is covered with $1''$ of felt, $\frac{1}{2}''$ of pine, and $\frac{1}{4}''$ of walnut. The car is of the usual pattern, with 16′ body; has four 30″

Fig. 2355.



Steam Street Car.

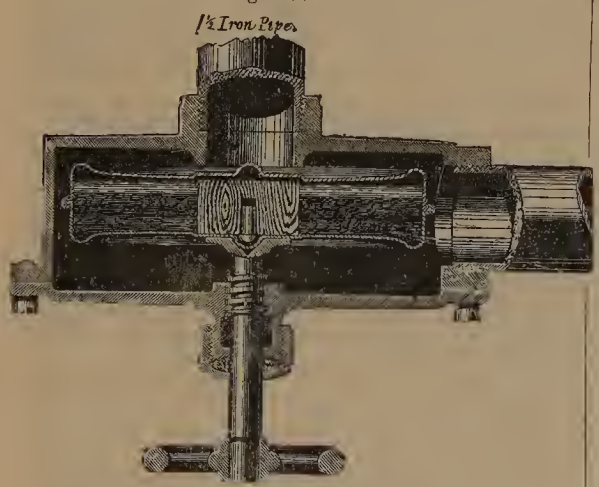
wheels, only one pair driven by the engine. Steam brakes stop it in half its length.

Running alone, the car takes 8 lbs. of anthracite per mile run. Two additional cars have been drawn on the Atlantic Avenue line, and an additional car is taken on certain trips when the greatest number of passengers offer.

Steam Trap. A trap to automatically drain the water of condensation from heating coils, and return the same to the boiler, whether the coils are above or below water level in the boiler, thus doing away with pumps and other mechanical devices for such purposes.

Maxim's patent steam trap, Fig. 2356. This trap is furnished with the Maxim gas machine, and consists of an outer shell in combination with a metallic expansion vessel, which acts as a valve and seats itself on the end of the inlet pipe. This vessel is filled with liquids which evaporate below steam heat; when heat is applied this liquid expands, and closes or practically closes the valve As the steam condenses in the pipe, the liquid in the expansion vessel cools

Fig. 2356.



Maxim's Steam Trap.

very gently, which relaxes the pressure, opens the valve, and lets the water out; steam follows, expanding the liquid, and the valve closes as before. The water can be let out at the desired temperature, by raising or lowering the expansion vessel by means of the screw spindle and hand wheel; raising lets off the water at a lower, and lowering at a higher temperature.

Steam Valve. A door-like cover or device to regulate the passage of gases or fluids through a port. See list, p. 2688, "*Mech. Dict.*"

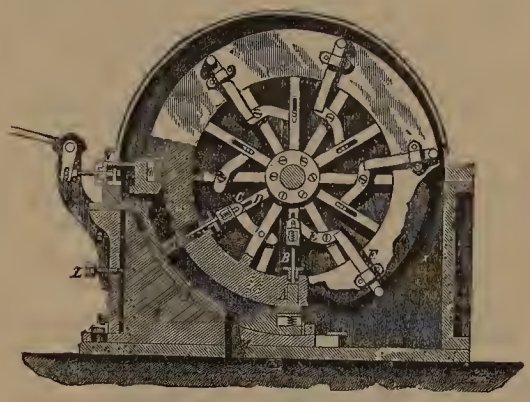
Purvis's steam valve is actuated directly by the motion of the engine piston without the aid of valve gear, and without the assistance of an auxiliary valve. The whole area and length of the cylinder are utilized. The valve is thrown through its entire stroke by line steam upon its differential areas, and cushioned by the same.

High pressure valve.
Dennis & Co., Br. . * "*Engineering*," xxii. 111.
Steam valve, *House* . . * "*Scientific American Sup.*," 1569.
Saunders . . . . . * "*Scientific American*," xxxix. 86.
Steam and water valve.
House, Br. . . . . * "*Engineering*," xxiv. 194.

Steam Wheel. In Thomas' steam wheel, Fig. 2357, the impulsive power is communicated only over a segment of the periphery instead of following the piston around the circle.

See ROTARY STEAM ENGINE, *supra*, and "*Mech. Dict.*"

Fig. 2357.



Steam Wheel.

Stear'ic Ac'id Ap'pa-ra'tus. Devices used in the extraction of the tallow from the original fats. The fats are inclosed in hair or cloth bags, and subjected to pressure to extract the fluid fats, or the fats are mixed with from 20 to 100 per cent. of water and 1 or 2 per cent. of lime, and kept at a heat of 200° C. for several hours.

Steel. 1. Steel is made direct from the ore by deoxidation followed by carburization.

2. It is made from pig-iron by decarburization. Oxidizing agents, solid or aëriform, are applied to it to eliminate the carbon.

3. It is made from wrought iron by carburization.

Professor Young gives the following outline of the two latter: —

Pig iron converted into steel by —
Solid oxidizing agents, iron ore, saltpeter, etc., without fusion: *Examples* — Puddled steel; Ricpe process; Ellerhausen process; Heaton steel.
Solid oxidizing agents, such as spathose iron ore, with fusion, — Uchatius steel.
Oxidizing agency of air, with fusion, — Bessemer steel.
Oxidizing and reducing gases, — Berard steel.
Wrought iron converted into steel by —
Fusion with pig iron, — Martin process.
Fusion with charcoal, — Wootz process.
Heating in charcoal without fusion, — Cement steel.
Heated in carbureted hydrogen, — Mackintosh process.

As steel occupies nearly the middle place between cast and wrought iron in its proportion of carbon, it may be prepared either by decarburizing pig iron, or, on the contrary, by causing wrought iron to absorb carbon. The processes to accomplish these ends may be arranged under five principal heads: A, Fabrication of steel by decarburization of crude or pig iron: B, by carburization of wrought iron; C, by mixing a wrought iron poor in carbon with a pig iron rich in same; D, by mixing pig iron with ore (the pig yields carbon which reduces the ore and transforms the reduced iron into steel); E, directly by means of ore; F, cast steel. Subdividing

these systems, we have the following methods under each heading: —

A. — METHODS OF DECARBURIZING THE CRUDE IRON.

1. Steel obtained by a long heating of the crude iron in an oxidizing atmospherc, the metal not being brought to fusion. (*a*) Tunner's method in sand, where the deoxidation is produced by means of the oxygen in the air. (*b*) Jullien's method, in forge scales or spathic ore. This produces malleable iron. (*c*) Herzeeles' method in steam. (*d*) Thomas' method in carbonic acid. The last two processes have not been employed to any great extent.

2. Natural steel: In this method, employed since the earliest times, the crude iron is melted in a refiuing furnace with wood charcoal, and decarburized by the ferrous oxide of the scoria. The product is purified by repeated refining.

3. Puddling: This process is the same as the preceding, from a chemical point of view, but is practiced in a reverberatory furnace heated with coal. It is necessary to purify the product by repeated refiuing or by trausforming it into cast steel.

The construction of puddling furnaces has undergone many changes. We may distinguish (*a*) the ordinary puddling furnace with fixed hearth and heated by coal, (*b*) the same hcated by lignite or peat, (*c*) the puddling furnaces of Schafhäutl and others, with mechanical rabbles desigued to diminish the labor so fatiguing to the workman. These, however, have been entirely superseded by new systems. (*d*) The Danks furnace, the hearth of which is formed of a hollow cylinder placed horizontally, and turning on its axis, gives a product of excellent quality, and is economical. The interior lining, however, is difficult to maintain. (*e*) The Ehrenwerth furuace has a horizontal circular hearth turning on a vertical axis. (*f*) The Pernot furnace also has a circular sole, which, however, is not horizontal, but slightly incliued, so that during its rotation the iron and scoriæ run to the lowest point and are thus in a state of continual motion; while the elevated parts of the hearth, together with the iron and scoriæ thereto adherent, are submitted to tbe oxidizing actiou of the air. This furnace realizes the advantages of mechanical puddling without needing any special liuing.

4. The Bessemer process: A current of air, finely divided, is passed through the liquid crude iron. The carbon, silicon, and a part of the iron burn, and the temperature is so highly elevated that the iron, decarburized in part or transformed into steel, remains molten. It is theu run into molds.

5. Bérard's modification of the above: Air and gases are alternately introdueed into the retort with different advantages.

6. Peters' process: The liquefied erude iron in a reverberatory furnace falls in the form of rain in a vertical chamber in which the furnace gases also pass, and in which air is blown so as to decarburize the metal to the desired degree.

B. — METHODS BY CARBURIZATION OF WROUGHT IRON.

1. Indian or Wootz steel: Wrought iron of extraordinary purity, obtained by treating a very pure ore in small chamber furnaces by the direct method, is hammered, made into bars, eut into short pieces, and placed in small erucibles with a few green leaves. The crucibles are hermetically sealed and heated for a long time at a high temperature. The irou is transformed into steel by uniting with it the carbon contained in the leaves, and the steel even partially melts. These half melted masses furnish the famous sword blades and plates of Persia and Damascus.

2. There are several other processes resembliug the Indian, which, however, are not carried on on a large scale. There are (*a*) the Mushet process, in which wrought iron obtained by the ordinary refining method is melted with powdered wood charcoal. (*b*) The Vickers' process, analogous to the preceding, with the addition of oxide of manganese. (*c*) The Stourbridge, Brooman, Thomas, and Binks processes, based on identical principles.

3. English cemented steel: Wrought iron of the best possible quality is, in the shape of bars, packed in clay boxes, together with wood charcoal coarsely pulverized. The heating continues for two or three weeks. Without melting, the iron is changed into steel, which by remelting is transformed into cast steel.

4. Parry's cupola steel: Fragments of wrought iron, melted in the cupola with a large consumption of coke or wood-charcoal, may be trausformed into steel or even into cast iron according to the length of the operation. This system offers an advantageous method of utilizing scrap, aud requires no special apparatus.

5. Chenot's process: In this the ore is reduced by heating it progressively with coal. A non-melted iron sponge is obtained, which is ground and separated as well as possible from the gangues by the aid of a magnet. Lastly, it is mixed with carboniferous substances, and melted under pressure. The principal disadvantage of this process is the difficulty of separating the gangues without losing the steel.

6. Casehardening has for its object the transformation of the surfaces of wrought iron objects into steel. It is done in two ways. (*a*) The pieces are placed in small sheet iron boxes and surrounded with chips of wood. The boxes are hermetically closed and heated in a forge fire, for 15 or 30 minutes, to an intense red heat. They are then removed quickly, opened, and their contents thrown into cold water, whereby the exterior steel shell is rendered as hard as glass. (*b*) The pieces are heated to a whitish red and moistened with ferrocyanide of potassium, which acts, by its cyanogen, on the iron, and transforms the surface into steel.

C. — METHODS BY FUSION OF A MIXTURE OF CAST AND WROUGHT IRON.

The two materials may be, both or only one of them, used in a melted state.

1. Bessemer steel, prepared by the ordinary method. The crude and wrought irou here are both liquid, while, as we have previously said, cast iron may be directly transformed into steel. The method most followed, and which leads most surely to the end in view, consists in completely decarburizing the crude iron in the converter, and in adding to the melted metallic iron a rigorously determined quantity of liquid crude iron. The carbon of the latter affects the previously decarburized iron, and makes a steel containing a given proportion of carbon.

2. Crucible steel is obtained by melting in crucibles a mixture of crude and wrought iron. The former liquefies first, and slowly melts the latter.

3. Martin's steel is similarly made, but replaces the crucible with a reverberatory furnace. The crude iron is liquefied under a thin layer of scoria on the concave hearth of a reverberatory furnace, heated to an inteuse red-white heat by a Siemens regenerator. Scraps of steel and wrought iron of all kinds in desired quantity are added, and the steel is run into molds of cast iron.

D. — METHODS BY A MIXTURE OF CAST IRON AND ORE.

Uchatius steel: The cast iron is granulated by running it into water while molten, and the grains are melted with spathic ore, peroxide of manganese, and wrought iron in crucibles. The ferrous oxide of the spathic ore is reduced by the carbon of the east iron, and the surplus of carbon unites with the wrought iron to make steel.

E. — METHODS BY PREPARATION DIRECT FROM THE ORE.

The Siemens direct process: The ore is melted alone, without addition of reducing material, at a very elevated temperature; then the iron is reduced and transformed into wrought iron or into steel by adding coal.

E. — CAST STEEL.

For the purification of steel by fusion, cemented, forged, and puddled steel are employed. To improve the qualities of the steel, and notably to augment its hardness, diverse substances are added. Thus we have: 1, silver steel; 2, nickel steel; and 3, wolfram or Mushet special steel.

The Japanese method of making steel is to mix a certain quantity of iron in pigs and iron in bars, cover the mixture with borax, and melt the whole for a week in a small fire-proof crucible. The borax serves to dissolve the impurities in the dross. When the metal is separated from the dross (which floats on the surface) and cooled, it is hammered hard, and alternately plunged into water or oil, after which it is cemented and tempered. The mode of cementing is as follows: The steel, on coming from beneath the hammer, is covered with a mixture composed of clay, cinders, marl, and charcoal-powder. When this plaster is dry, the whole is subjected to a red heat, and the steel is afterwards cooled very slowly in warm water which is allowed to become tepid. Steel thus obtained is not very supple, but extremely hard, because it is not properly tempered or completely freed from its impurities. It would not do for making watch-springs, but is used by the Japanese for swords and sabres which are tempered as many as eleven times, and knives which are tempered four times.

(*Metallurgy.*) Greiner's classification of iron products: —

Carbon, per cent.	Iron Series (welded).	Steel Series (melted).
0. to 0.15	Ordinary iron.	Extra soft steel.
0.15 to 0.45	Granular iron.	Soft steel.
0.45 to 0.55	Steely iron or puddled steel.	Semi-soft steel.
0.55 to 1.50	Cemented iron or steel.	Hard steel.

See SPONGE PROCESS, *supra*.
See "*Mech. Dict.*," pp. 2363, 2364, 2365, 2366.
Henderson Steel . . "*Iron Age*," xix., Feb. 1, p. 15.

Sten'cil Paste. A mixture of any ordinary pigment with chalk or carbonate of magnesia, to form a paste of the required consistence.

Sten'cil Pen. A pen or needle reciprocated by electric or pneumatic force, for multiplying tracings, etc. Fig. 2358 shows a simple form of pneumatic pen.

Fig. 2358.

Stencil Pen.

Sten'o-chrome. A print showing the colors, shades, and arrangement of a mosaic, made by forming a mosaic plate of colored sections similar to the one to be copied.

Ste'no Compress'or. (*Dental.*) A spring pad for closing the saliva duct, and absorbing the saliva during operations.

Step Gage. The standard double corrective gage, Fig. 2359, is for testing and correcting fixed caliper gages, and also as a reference to prove dimensions within its range.

Fig. 2359.

Double Corrective Step Gage.

Step Head'stock. In a watchmaking lathe the step head stock, as its name indicates, has a step or conical bearing at the rear of the spindle to reduce friction. This head is for pivoting, jewel polishing, and other work requiring very high speed.

Step Pad. The foot-rest or tread of a carriage step.

Ste-re-om'e-ter. An apparatus for illustrating various mathematical problems.

It has two frames, the upper one being a square, the sides of which are three feet long; and the longer one is formed by two such squares. Both frames are kept in position by four small columns, 4′ in height, and standing on four legs, by which the whole is supported and fastened to a common table. In these squares graduated cross-bars (of any desired number) are fastened by screw-clamps. They move horizontally in two directions, parallel to the sides of the square, while similar bars, 4′ long, are perpendicular to the frames and parallel to the columns. The cross-bars and framework are made in two pieces of ½″ by ⅛″, leaving between them an open space of 3-16″, in which again a simple screw-clamp moves, holding a needle in position, perpendicular to the bars and frame. These needles are pieces of strong common wire, flattened a little on one end, with an oblong hole in the end. By this arrangement a mechanical way is found to determine the position of any point in space within the apparatus. The shifting of the cross-bars (say north or south), the moving of the clamp in the split of the cross-bars (east and west), and the moving up and down of the needle in the clamps, are true representations of the equations of a point in space. The position of an unlimited number of points can be determined, and, consequently, any solid figure can be represented in contour lines by drawing wires — or, better still, elastic silk cords — through the corresponding points.

Stif'fened Chain Sus-pen'sion Bridge. The first bridge of this kind was erected at Pittsburg, Pa., in 1876-1877. The bridge is stiffened by means of rigid cords which extend (above the chains), at an undeviating angle from the towers to the center of the middle span (800 feet long), where they are connected by a hinge to allow for expansion and contraction.

Stif'fen-ing Ma-chine'. A trough and pair of squeezing rollers used in putting the stiffening into felt hat bodies.

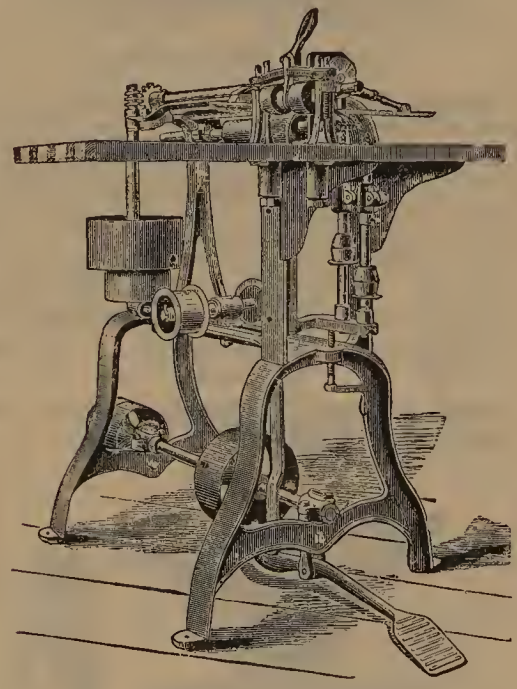
The stiffening is to enable the hat to maintain its shape. a thicker stiffening material is used for the brim than for the crown, and a more expensive material for fine hats than for common ones. A solution of shellac for first-class goods; Irish moss and glue for the rougher article. Two vats are employed and contain the respective stiffenings; the whole hat is submerged in the thinner stuff and the superfluous matter is squeezed out of it by passing it upward between the rollers. The brim alone is dipped in the other vat.

The troughs are heated by steam to keep the stuff liquid, and the hats after this process are ready to be blocked. This is the shaping, flattening the tip, stretching out the brim, etc. See HAT-BLOCKING MACHINE.

Stile Bo'rer. A machine for boring holes in the vertical parts of a window or shutter frame.

In Fig. 2360, the two vertical bits are used for blinds only, and will bore without any previous marking or laying out,

Fig. 2360.



Colburn's Blind Stile Borer.

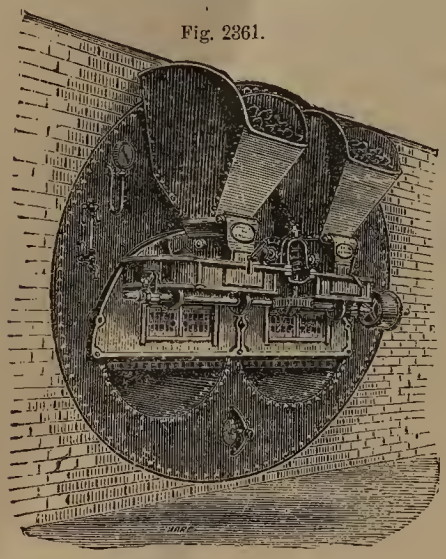
8,000 holes per hour. The stiles, after being jointed, are placed upon the table, with a ratchet or pattern between them, the lower ends of the stiles resting against two blocks, which are securely fastened to the end of the pattern, and are moved over the bits by means of a pawl working in the notches of the pattern. It spaces its own work at any distance apart, from 1″ to 1⅞″, and bores the entire length of the stile without stopping. The mortises are marked on the edge of the stile while the machine is in operation, from corresponding marks on the edge of a thin strip which has been previously laid off and tacked to the side of the pattern, and which can be replaced with any length required. The boring being done from the under side of the stile, the chips drop freely from the bits, and leave the holes of a uniform depth, so that the pivot of the slat may work on the end instead of the shoulder, which renders them less liable to bind or stick fast on the paint.

Stock Stone. (*Leather.*) A flat rectangular scouring-stone, 5″ or 6″ long and 0.5″ thick, fixed

in a stock or handle. It is used for scouring, stretching, and removing inequalities in the leather.

Sto'ker, Me-chan'i-cal. Henderson's mechanical stoker (English) has a fuel hopper placed over the fire-door, and from which it is gradually fed into the furnace by automatic gear driven by the engine. See Fig. 2361.

Fig. 2361.



Henderson's Mechanical Stoker.

Stone, Ar-ti-fi'cial. Stones formed by a process of treating a combination of lime and sand.

Ternikoff exposes equal parts of lime and sand to a temperature of 150° C. for several hours in the presence of steam. The material is then pressed and exposed to the air.

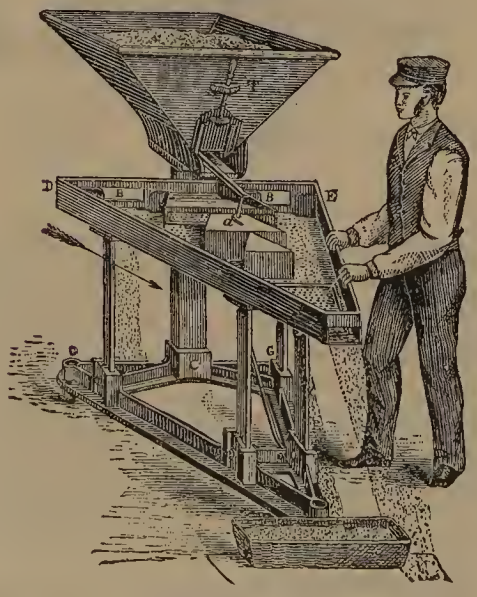
Glaser mills 4 to 6 parts fine sand to 1 of slaked lime and exposes for three days to a high temperature under a pressure of more than three atmospheres; it is then pressed.

Hosmer subjects limestone, cut to shape desired, in boiling water to 5° atmospheric pressure, and then places them in an alum or colored bath, to color as desired. See p. 2392, "*Mech. Dict.*"

Hammered artificial stone, "*Iron Age*," xviii., September 7, p. 3.

Stone Clean'er. For cleaning stones or clods from wheat or other grain.

Fig. 2362.



Stone Cleaner.

In Fig. 2362 the tray has a rocking motion on its supporting bars, the crank making 115 turns per minute. The grain placed in the hopper discharges at the lifted gate, runs over the slanting board, and into the bed of the tray. It is divided to each side, and, as the tray is pushed laterally back and forth by a quick motion, the contents are sorted according to gravity. The wheat issues at the rear ports, *B*, and the stones at the front, *C*, the lowest part of the tray. The apparatus is adjustable for inclination, the front end being kept the lowest. The stones being heavier than the grains and of angular shape, resist the backward blow of the oblique faces of the central block and pursue their way down the slope to the front while the grain passes out at the rear. See SEPARATORS.

Stone Cleav'ing Ma-chine'.

Stone cleaving for dividing granite is effected by means of a prismatic steel cutter inserted with wedges in the under side of the hammer, and opposite a similar one below on the anvil bed. The granite block to be cleft is pulled on rollers over the lower cutter (which is slightly higher than the rollers), and into the proper position. Then a rapid series of blows is given from a short height, followed by a strong blow from a great height. Thus a plate is cut vertically with accurately even surface. The block is next pushed on one plate-thickness, and the process is repeated. The plates obtained are afterward divided into cubical blocks by means of a steam hammer, arranged quite like the former except that the plates, instead of lying on rollers, are placed on small tables resting on spiral springs. By the weight of the stones the springs are compressed, so that the stones come to lie on the lower cutter.

Stone Cut'ting. The modes of dressing stones for masonry come under several heads. Unsquared stones or rubble are perhaps hardly included in the definition, but may be included for completeness of statement.

See under the following heads: —

Bush hammered.	Pitched-face stone.
Crandaled.	Quarry faced.
Cut stone.	Rough pointed.
Diamond paneled.	Rubbed.
Drafted stones.	Rubble.
Fine pointed.	Squared stones.
Peen hammered.	Tooth-axed.

All stones used in building come under one of three classes, namely: —

I. Rough stones that are used as they come from the quarry.

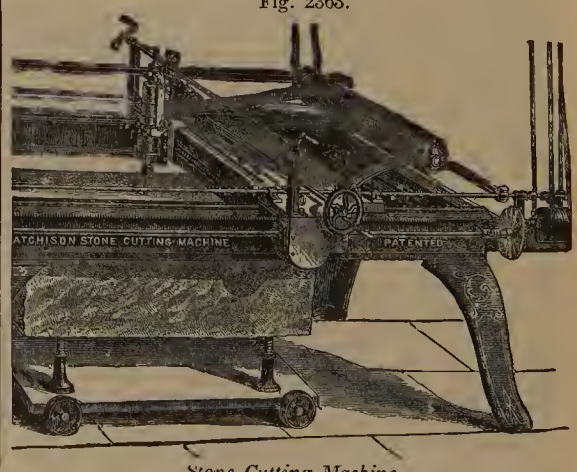
II. Stones roughly squared and dressed.

III. Stones accurately squared and finely dressed.

In practice, the line of separation between them is not very distinctly marked, but one class gradually merges into the next.

Stone Cut'ting Ma-chine'. The Tilghman sand blast will execute in ten minutes what would take a skilled stone-cutter a whole day. The pattern to be worked is cut in and through a flat iron or wooden plate which is fastened on to the stone. The jet-pipe traverses the pattern and the sand cuts away the parts of the stone not protected by the plate. Common sand, crushed agate, and small granules of iron, are used in cutting stone.

Fig. 2363.



Stone Cutting Machine.

Atchison's stone cutter, Fig. 2365, has two tools arranged in a strong head-piece, attached to a moving platen, similar to the iron planing machine.

This platen, with the head-piece, is made to move forward and backward over the stone, and the tools, having a perpendicular, reciprocal, rotating motion, cut the surface at the rate of not less than 6,000 blows per minute. The tools are semi-circular in shape at the edge, and can be used constantly for at least forty-five minutes without changing; thus one set of tools will cut not less than 270,000 blows without re-sharpening.

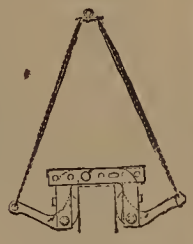
One man can operate three machines, and sharpen his own tools, which sharpening is done readily by the use of a "die."

Among the advantages claimed for this machine are: —

The slight cutting blows produced by this peculiar motion leave the surface "solid" and free from "stunning"; all "wind" or irregularity of surface is overcome, without the process of "sighting" or measuring; the edges of the stone are evenly and perfectly cut without "chipping." This principle is applied to machines for ornamental as well as plain work, in cutting moldings, cornices, ornaments, letters, etc., on all kinds of stones.

Stone Lift'er. Shepherd's lifter, Fig. 2364, has a pair of eccentric lever griping jaws, pivoted in a frame formed of two parts. These parts are adjustable along each other, and may be secured by pins so as to shift the jaws nearer together or further apart in order to adapt for different sized stones. The arms of the jaws are connected by chains to an eye plate, and to the latter the hoisting rope is attached.

Fig. 2364.

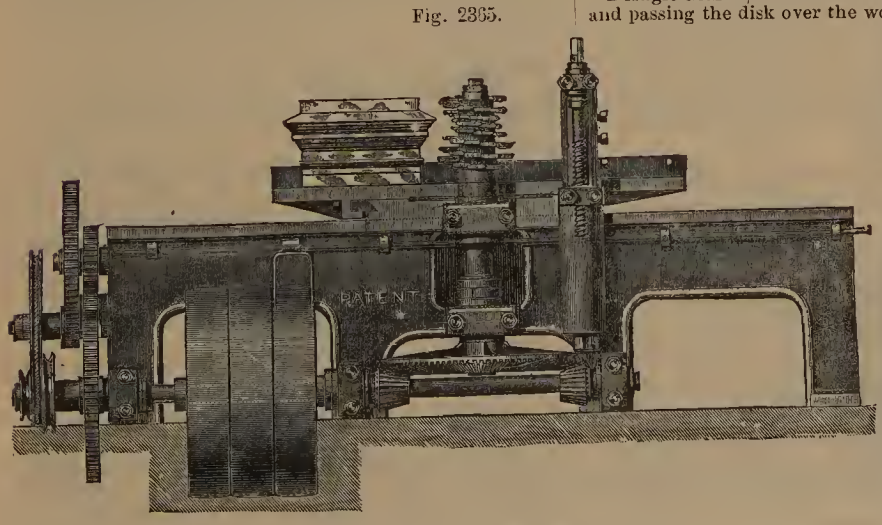


Stone Lifter.

Stone Mold'ing Ma-chine'. In Hunter & Fothergill's stone-molding machine the chief feature is the employment of cutting plates of different lengths, all lettered, so as to be easily picked out and set, like types, to mold. These being built on a shaft, revolve, and take out the rough or waste, comparatively near the mold, when a tool to profile passes several times over and finishes the work. The stone is laid on a cant-table to cant to the proper angle.

The tools in the planing and molding machines are fastened to holders that are bolted to the shafts. There is a pair of tools at each end of the holder. Although the holders, when fixed upon the shafts, act obliquely, as appears upon the stone passing under the cutters, and in such manner as seems incompatible with the production of any definite form, they are nevertheless so arranged, and so act as to turn out moldings of a large size, with many members, rough-cut, with great accuracy. The work is finished by being passed two or three times under cutting or scraping tools of the precise form of the molding to be produced. For a molding of many members, some of them deeply cut, more than one of these finishing-tools is sometimes employed. Mitred work is also executed by the machines with perfect accuracy.

Fig. 2365.



Hunter & Fothergill's Stone Molding Machine.

Stone Sep'a-ra-tor. A device invented by Higuette for removing stones and clods from grain. See STONE CLEANER, *supra*.

Stone Split'ting Ma-chine'. Brook's splitting machine has a row of upright square-shaped bars of steel, bevel-pointed, on which the stone sits. The steam hammer has a corresponding set, with a tooth immediately over each lower tooth. The sudden shock disintegrates the stone in the line of the teeth.

Stone'ware. (*Ceramics.*) *Grès cerame.* A class of ware which may be said to hold a middle place between hard porcelain and fine English faïence.

The paste is composed of fat clay with quartzose sand, and gives a very solid and strong ware, varying in color from a pearl gray to a brown red. It is dense and impermeable, and resists corrosion by acids, being specially adapted for table use.

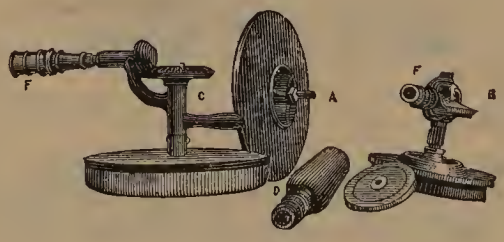
Fine varieties consist of ornamented objects made of a fine paste, white or of various colors, delicately fashioned and enriched with figures in relief, often in paste of another color.

Stone'ware Force-pump. One for pumping acids, bleach, alkalies, vinegar, or other liquids injurious to metals. The working parts are composed entirely of stone-ware, and the gland packed with asbestos.

Stone'ware Kiln. (*Ceramics.*) The stone ware is a reverberatory on the same principle as the common faïence furnace. See FAÏENCE.

Stone'-work'ing Em'e-ry Tools. In the tools shown in Fig. 2387 *A* is the sanding disk; *B* the "B Augle Gear," for emery wheels; *C* the "C Angle Gear," for buffing wheels; *D* fluting roll; *E* disk, for cutting medallions.

Fig. 2366.



Emery Tools.

For plane surfaces, the process is to attach the sanding disk or spelter rings to end of the flexible shaft, by means of the "B Angle Gear"; the flexible shaft entering the hand piece *F* and passing the disk over the work to be finished, with sand and water under the disk which is being rapidly revolved. When the surface being worked has been straightened, the sanding disk is removed, and the plate carrying emery wheel is used in its place; when the work has attained a sufficient smoothness, it is thoroughly cleaned, and then "buffed" by means of the disk shown in "Angle Gear *C*." This buffer is made of heavy felt, or similar material covered with canvas; it is revolved much more rapidly than either of the preceding disks, and the surface being finished is coated with "Tutty," during the operation; finally, a second buffing disk is used without the tutty, which brings the work up to completion. This process is varied somewhat with different grades of

stones, but is in the main the plan adopted. The roll *D* is used for fluting work — as columns, edgings, moldings, etc., etc. A rough channel is cut where flute is desired, the roller placed in it, and rapidly revolved; sand and water is also used as with the sanding disks, and the roll is passed back and forth in the channel being cut. In this way channels of 12′ long can be cut and finished in a few minutes. *E* shows a corrugated disk for cutting medallions or rosettes in stone. They are attached to the "Angle Gear *B*," and held up to the work to be done; used as sanding disks they cut rapidly and effectually, doing their work at a very low price.

Ston'ing. (*Leather.*) Driving the stock stone over the leather to remove inequalities, streteh it, and render the grain smooth.

Ston'ing Jack. (*Leather.*) A machine in which the jack is furnished with a stock stone to work the leather.

Stope. (*Mining.*) One of a series of steps or beds into which the upper surface of an excavation is cut; to excavate in the form of steps above a drift.

Sto'ping. (*Mining.*) The act of stoping or breaking down the surface of an excavation with a pick.

Sto'ping Drill. (*Mining.*) One for excavating drifts or horizontally lying beds or steps. Fig. 2367 represents a stoping drill mounted on a column, with a claw-foot and and a jack-screw at top for securing the same in an upright position. This is peculiarly adapted to small tunnels, adits, and stopes, from $4\frac{1}{2}' \times 6'$ to $6' \times 6'$ or even larger drifts, and is a simple, cheap, and good arrangement for the desired purpose.

Fig. 2367.

Drill Mounted for Shaft Work.

Stop Plate. A metallic plate in the inside of a journal-box which forms an end-bearing for the axle and checks its end-motion. The plate is either held in position by flanges cast in the box, or is attached to the journal bearing or its key. — *Forney.*

Stop Watch. A time-piece registering seconds and minutes, used in making tests for density.

Goodwin's "American Gas-light Journal," * July 3, 1876, p. 7.

Minute clock, *Ibid.*

A time-piece marking fractions of a second which can be stopped instantly by pressure on a pin.

Stor'age Bat'te-ry. (*Electricity.*) A secondary battery. A galvanic battery devised to act as a conservator of electrie force to be withdrawn as required. See *Hinston & Thomson's* battery, "*Journal Franklin Inst.*," 1880, noted in "*Manufacturer and Builder*," * xii. 36.

The Faure battery is thus deseribed in the London "*Times*":—

A Faure battery (improvement on Planté's *pile secondaire*) was charged with the electric fluid direct from the ordinary Grove battery. The receptacle consists of four Faure batteries each about 5″ diameter and 10″ high, forming a cylindrical leaden vessel and eontaining alternate strips of metallic lead and minium wrapped in felt and rolled into a spiral wetted with aeidulated water, and the whole placed in a square wooden box, measuring about 1′ eubie and weighing 75 pounds. This was proteeted by a loose wooden cover through which the leaden electrodes protruded. they being flattened down for convenienee of transport.

This box of "electrie energy" was sent by M. Faure, in Paris, to Sir Wm. Thomson, in Glasgow, where the "box of eleetricity," was received intaet and potent, holding by measurement within that small spaee of 1′ eubic a power equivalent to nearly 1,000,000 foot-pounds.

Storm Valve. A screw-down valve to supersede the duty of a gravitating valve in a ship's side during bad weather.

Stove Truck. A truck to run under a stove, having a platform operated by a lever to raise the stove off its feet. The lever is then locked and used as a handle to guide the truck.

Straight'en-ing Block. The anvil on which buckled saws are straightened.

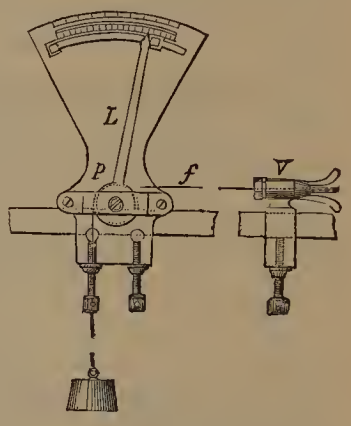
Strain In'di-ca'tor. An instrument for determining by optical means the extension or compression of materials under strain.

*Stromeyer . . . . . * "Engineering," xxx. 337.

Strain Meas'ur-er. An apparatus designed to measure directly the strains to which the different parts of any structurc are submitted. It will operate in any position whatever, and under all possible conditions, multiplying the amount of flexure itself, — a result not always obtained in apparatus of this nature.

A metallic wire, *f*, is attached at one end to a winged nut, *V*, which allows of the instrument being adjusted for use. This wire passes over a pulley, *p*, and carries a counterpoise. To keep it from slipping it is held by a small clamp placed in the channel of the pulley. The latter carries an index needle, *L*, which multiplies the distanee traversed by its eircumference ten times, and the extremity of which moves across an are graduated in millimeters. The index needle also moves two slides whieh show the maximum of elougation or compression. The apparatus and the serew to which the wire is attached are mounted in two different ways, one designed to fasten the whole to a truss rod or to the foot of a T-irou, and the other to attach the apparatus to any ordinary surface. The apparatus having been placed in position, the index having been brought to zero, and the wire being kept at a uuiform tension by the weight, it will be seen that if the object to whieh it is attaehed elongates or shortens, the pulley will be aetuated by the wire, and the lever *L* will multiply the actual amount of the strain exerted. To study maximum strains the two sliders are moved up against the extremity of the needle. The apparatus may be used on parts of a structure inclined at any angle whatever. The sensitiveness of the apparatus may be known when it is stated that a lighted match placed under the wire will cause the needle to be immediately defleeted one, two, and three millimeters. See Fig. 2368.

Fig. 2368.



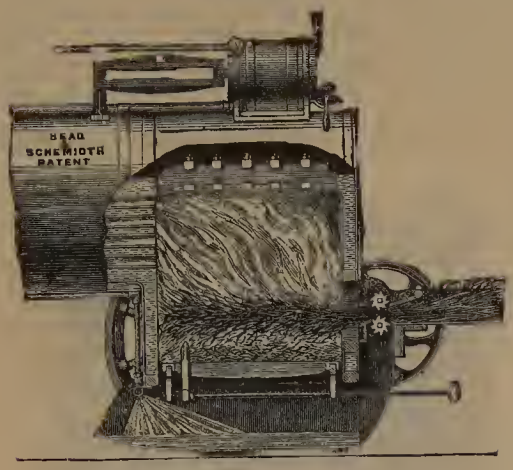
Strain Measurer.

Strap. (*Nautical.*) Or *strop.* The band of iron or rope which goes around a tackle-block.

Strass. (*Glass.*) A variety of lead glass made for imitating gems.

Straw'-burn'ing En'gine. An engine to enable persons residing in countries where coal and wood are not indigenous, or are only to be obtained at a great cost, to generate steam from the vegetable products on their estate. In Russia, Hungary, and on the borders of the Danube, this engine has been found to economize from 30 to 40 francs per day by using the refuse straw instead of coal and wood. In Egypt it is used for working the irrigating machinery of the cotton fields with the refuse cotton stalks, and actual practice has shown that the refuse stalks of a crop of cotton are sufficient to generate steam for working the pumps for irrigating the land, consequently the land finds its own fuel for irrigation. In India these engines are used in the tea plantations for driving the machinery, and

Fig. 2369.



Straw Burning Engine.

the jungle grass which grows outside the tea-gardens is used as fuel instead of coal and wood. In some cases it is used for burning the refuse of the sugar-cane from the mills. See Fig. 2369.

Stream Fence. One across a water-gap. A common form has the panels pivoted permanently to the part at one side of the stream, while the other end is held by pins that will either break under the pressure of the freshet, or allow the end to rise when the stream reaches the board, and allow it to swing loose from the pins. Barbed wires are stretched in same manner with a floating block attached to the loose end.

Street Car. See STEAM STREET CAR, *supra.*

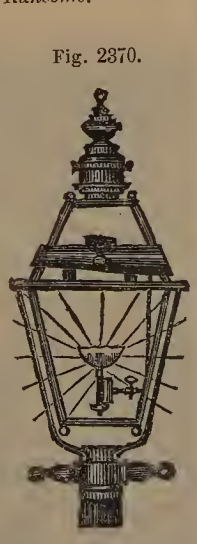
Street Car Mo'tors. See "*Scientific American Supplement,*" p. 2125, for an account of the early street-car efforts of *Latta* and *Todd;* the *Lamm* fireless locomotive at New Orleans; *Baxter's* engine with compound cylinders; *Grantham's* engine (Eng.) improved by *Wood.*

Loftus Perkins. Belgian street-car engine.
Société Métallurgique et Charbonnière, of Belgium.

Francq.
Merryweather.
Holt.
Baldwin, et al.
Bède & Co.
Hughes.
Ransome.

See *Clark's "Tramways, their Construction and Working."* London.
See also Mekarski compressed air street-car motor.*
Lamm & Francq fireless locomotive *
"*Paris Exposition* (1878) *Reports,*" *iv. 62–65
See STEAM STREET CAR.

Fig. 2370.



Street Lamp.

Street Lamp. Fig. 2370 shows a tank or reservoir, adjusted to the outside of a street lantern. Connected with the reservoir is a pipe and valve, to which is attached the solar gas burner. By means of a chemical process, the liquid, on its passage through this burner, is converted into gas, which gives a bright, steady flame.

The material used in making the gas is re-distilled naphtha of 72° to 74° gravity.

Strike. The piece on which the latch of a door impinges in closing.

Fig. 2371.

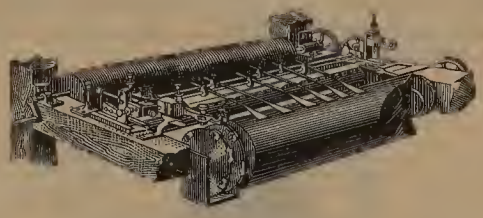
Strike.

Fig. 2371 has a roller for the bolt or latch to strike against, reducing the friction, and forcing the bolt back without noise.

(*Mining.*) The extension of a lode in a horizontal direction.

Stri'ker. The regulator which causes the pens of a ruling machine, in perpendicular work, to strike the head- or cross-line at regular intervals. In the illustration, Fig. 2372, are the cams with sloping corners for operating pen-beams and pens; the cams operating short line, the lifting arms and lifter; and the cam operating gate.

Fig. 2372.



Striker.

Stri'ker Plate. The nosing of a lock-keeper.

Strop. (*Nautical.*) Preferably *strap.* The band around a tackle-block.

Stub. 1. A blunt pointed pen.

2. Short files for finishing in and around depressions; has a holder fitting in top for parts where the fingers cannot get. See Fig. 2373.

Fig. 2373.

Stub.

Stuc'co. There are two species of stucco used in France: one with chalk and the other with gypsum.

The chalk lime is slaked and mixed with other matters in powder, generally white marble dust. The gypsum stucco is similarly compounded, but is principally used in interiors. To imitate colored marbles the colors are added before the surface has entirely dried.

In Paris elaborate cornices and architectural moldings are made by forming them *in situ* by means of pattern gages or templets, projecting nails driven into the wall serving to hold the plaster in relief.

Polishing is done by a whetstone of fine grain, one hand holding a sponge with which the surface is occasionally wetted. The last polish is given by a piece of felt, saturated with oil.

Fig. 2374.

Stuffing Machine.

Stuf'fing. (*Leather.*) A mixture of tallow and either neat's foot oil or sperm oil, with which dampened leather is coated. The object is to render the leather supple and impervious to water.

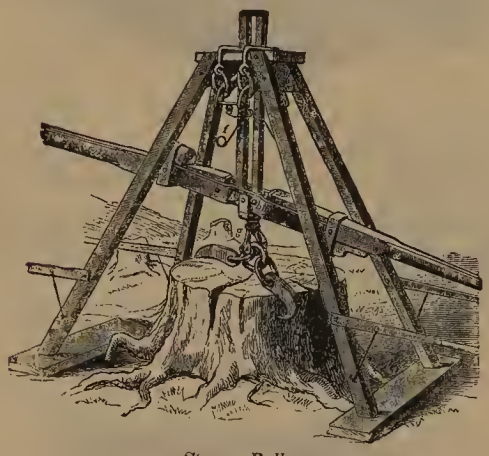
Stuf'fing Brush. (*Leather.*) A stiff brush used in stuffing leather.

Stuf'fing Ma-chine'. A steam chest into which the oil and tallow are introduced and rubbed into the leather by the action of rollers and beaters. See Fig. 2374.

Stull. (*Mining.*) A framework covered with timber or planks to support rubbish in working a stope.

Stump Ex-tract'or. In Fig. 2375, from the center of a tripod is suspended a ratchet wheel, over which a chain is loosely thrown, each link fitting in a corresponding groove. To this wheel a lever is attached, and so arranged that twenty pounds' power will raise, it is said, a ton. See Figs. 6011–6016, "*Mech. Dict.*"

Fig. 2375.



Stump Puller.

Stump pullers are of the lever and claw style, or the tackle, toggle, screw, windlass, or capstan order.

Stump Joint. The form of joint used in the folding carpenter's rule. The ends or stumps of the parts when in line, abut against each other, and allow movement in only one direction.

Sty'lo-graph'ic Pen. A reservoir pen, shaped like a pencil, in which the flow of ink is regulated by pressure of a style upon the paper.

Sub'cu-ta'neous In'stru-ments. (*Surgical.*) See

Shrady's saw, knife, and bone rasp, Fig. 87, Supplement.
Adam's saw . . . . . Figs. 10, 11, Supplement.
Knife . . . . . Fig. 9, Supplement.
Hypodermic syringe . . . . . Pages 70, 71, Part I.
Tiemann's "*Armamentarium Chirurgicum.*"

Sub'cu-ta'ne-ous Saw. One to bare and roughen the ends of fragments in bony sections without injuring the flesh.

Fig. 2376 consists of a trocar, fenestrated canula, and staff, with handle and blunt extremity. A portion of this staff

Fig. 2376.

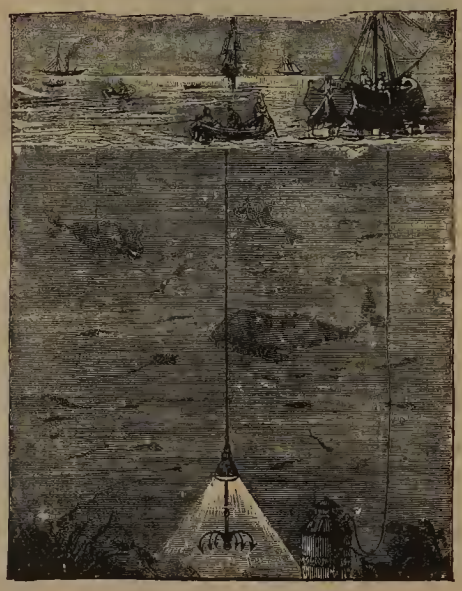
Subcutaneous Saw.

at a short distance from the extremity is flattened, one edge, *B*, being made into a knife-blade, and the other edge, *C* being provided with saw-teeth. This staff is intended to replace the trocar in the canula after the latter is introduced. When in position, either the saw (*C*) or the knife (*B*) edge of the shaft, according to the way the latter is turned, corresponds with the opening in the canula.

Sub'li-ma'tion. (*Mining.*) The theory that the vein matter was introduced in a gaseous condition.

Sub'ma-rine' E-lec'tric Light. Barnet and

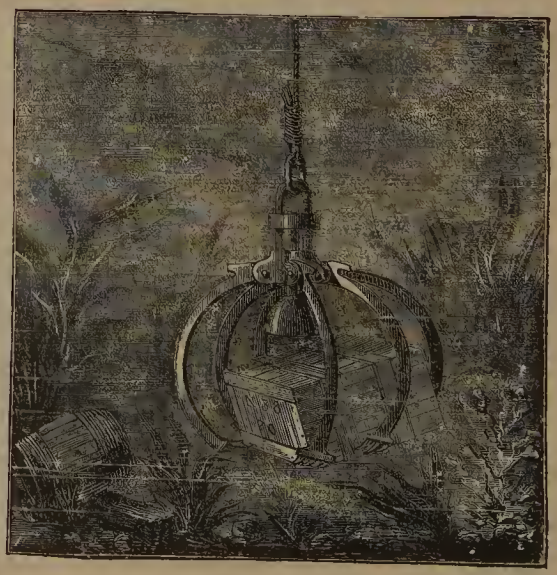
Fig. 2377.



Submarine Electric Light.

Foster compress pure oxygen into a cylindrical reservoir of the plate iron, under a pressure of thirty atmospheres. This oxygen is supplied by a flexible tube to an alcohol lamp provided with means for the escape of the gaseous products of combustion. This furnishes a brilliant light for a period of four hours. Heinke and Davis use a glass cylinder upon the diver's helmet, which contains an electric lamp of polished copper. The carbons are arranged to last four hours without being renewed. The whole apparatus weighs about 27 kilograms, and is capable of furnishing a light equivalent to 20,000 standard candles. See Fig. 2377.

Fig. 2378.



Submarine Grapple.

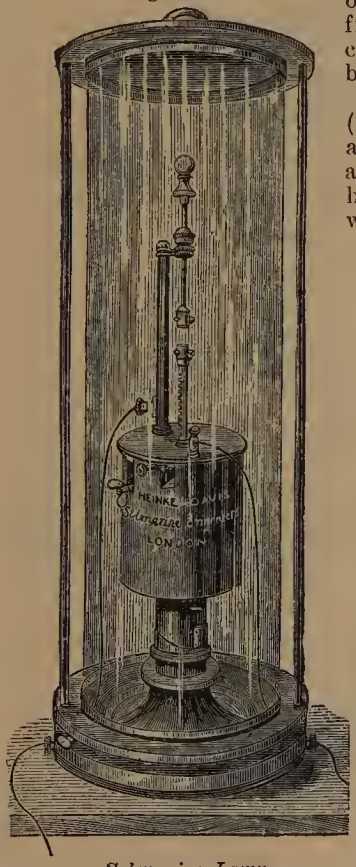
Sub'ma-rine' Grap'ple. For recovering articles on the ocean bed. In Fig. 2378 the grappling fingers pivoted in the head of the block are kept distended by the weight in the center. On the grappling of an article by one or more of the claws the weight is pulled up against the head, and the remainder of the claws close around the article.

Sub'ma-rine' Gun. Experiments on firing guns under water, with a view of sinking vessels by penetration of the hull below the water-line, extend over a long number of years. St. Cyr, 1797, suggested suspending a mortar between two boats. Fulton, 1814, succeeded in penetratiug a bulk-head by a cannon fired under water. Philips, of Indiana, 1855, Woodbury, Boston, 1861–1864, arranged ports permitting guns to be fired from below the water-line. See "*Mech. Dict.*," p. 2439.

Sub'ma-rine' Lamp. One for explorations in the ocean's depths. The electric light has taken the place of the oil lights formerly used, requiring no tubes or pumping to supply air to the flame, and giving a sure and brilliant light. See Fig. 2379.

Suc'tion Fan. One for withdrawing the chaff and dirt from grain, or steam and hot air from meal as it comes from the burrs, by suction.

Fig. 2379.



Submarine Lamp.

Suc'tion Pipe. (*Hyd. Eng.*) The air-tight pipe under a water-wheel, turbine for instance, which intervenes between it and the level of the tail race. Believed to be the invention of Z. and A. Parker, of Ohio, now common in Europe. It makes the wheel to be placed not exceeding 30′ above the tail race and yet render the whole fall available.

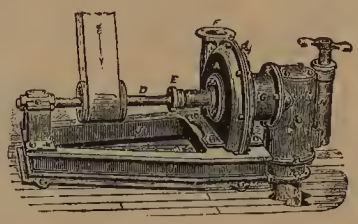
Suc'tion Pri'mer. A device to charge a steam pump ready for starting.

At the extreme right in Fig. 2380 is a small force-pump, worked by hand, used in charging the main pump. Before starting the large pump, the pet-cock, shown on the top of the shell, is opened, and the primer is worked until no more air is driven from the cock. When the pump is evidently full, the pet-cock is closed, and the main pump is then ready to be started.

The pump may be emptied by withdrawing the two screws shown near the top of the suctiou-pipe.

Sud'den Grip Vise. One that can be opened or closed the full play of the jaws without the tedium of turning up. See Fig. 2381.

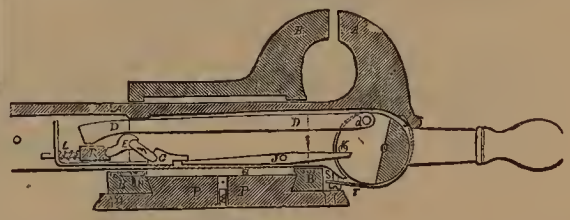
Fig. 2380.



Suction Primer.

To open the jaws, lift the handle to a horizontal position or as high as it will go, and draw towards you. To grasp the work, push in the sliding jaw until it presses against the work, then depress the handle, which causes the jaws to securely grasp the work and at the same time locks the swivel.

Fig. 2381.

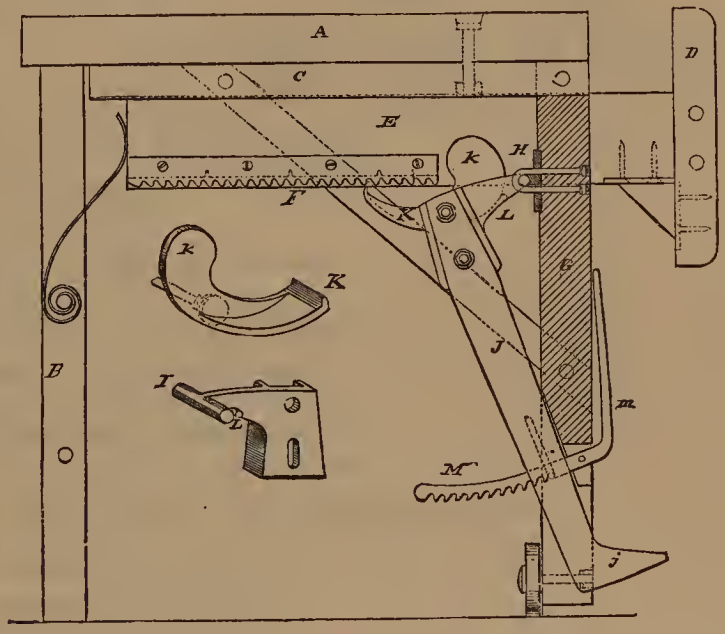


Sudden Grip Vise.

Fig. 2382 is a complementary vertical section of a bench vise devised by Messrs. G. H. and W. H. Knight, of Cincinnati.

The invention is an improvement on those bench vises whose movable jaw is capable of being quickly opened or closed by hand, and, after closure, of being clamped with great force so as to grip the work.

Fig. 2382

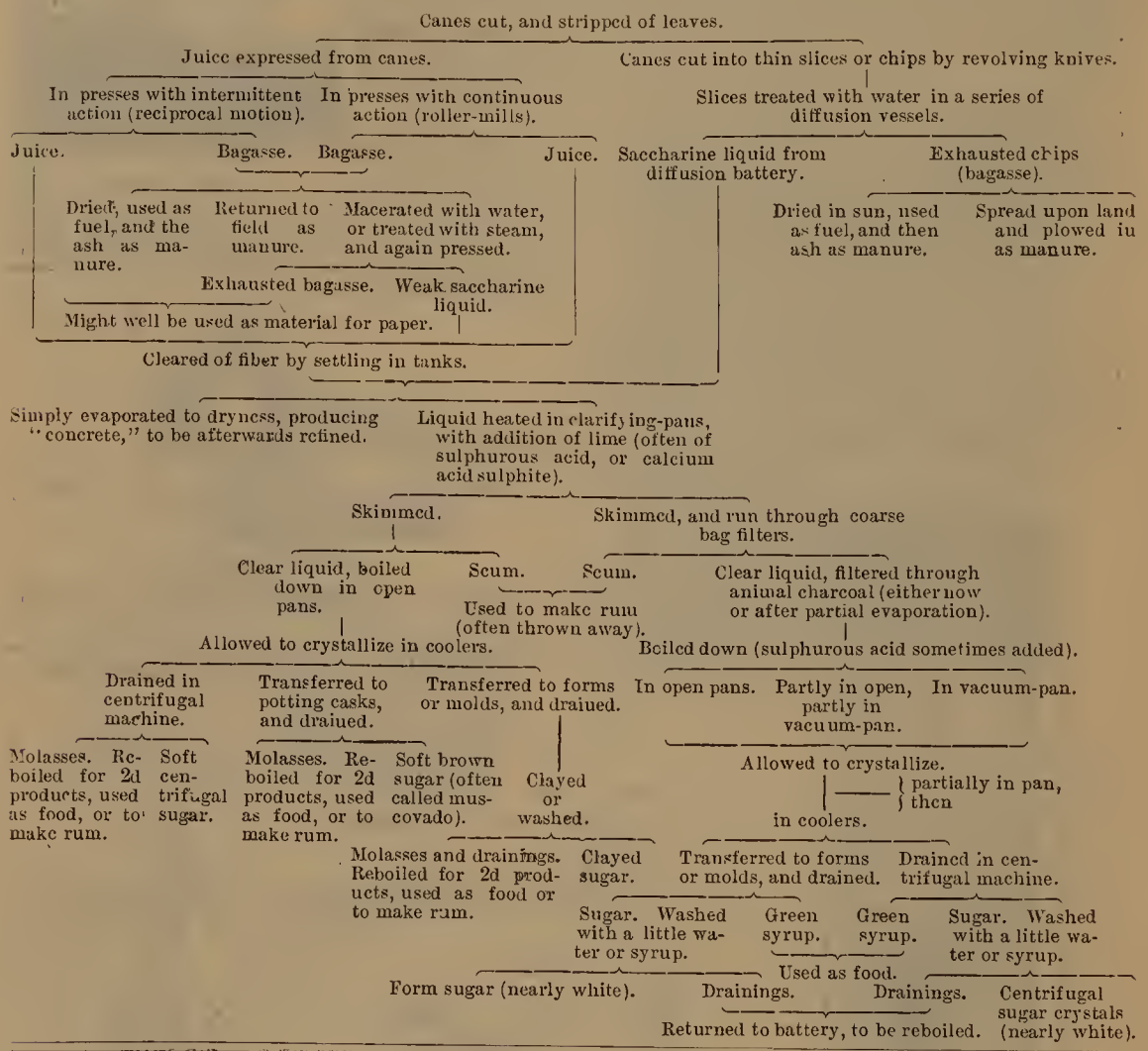


Improved Sudden Grip Vise.

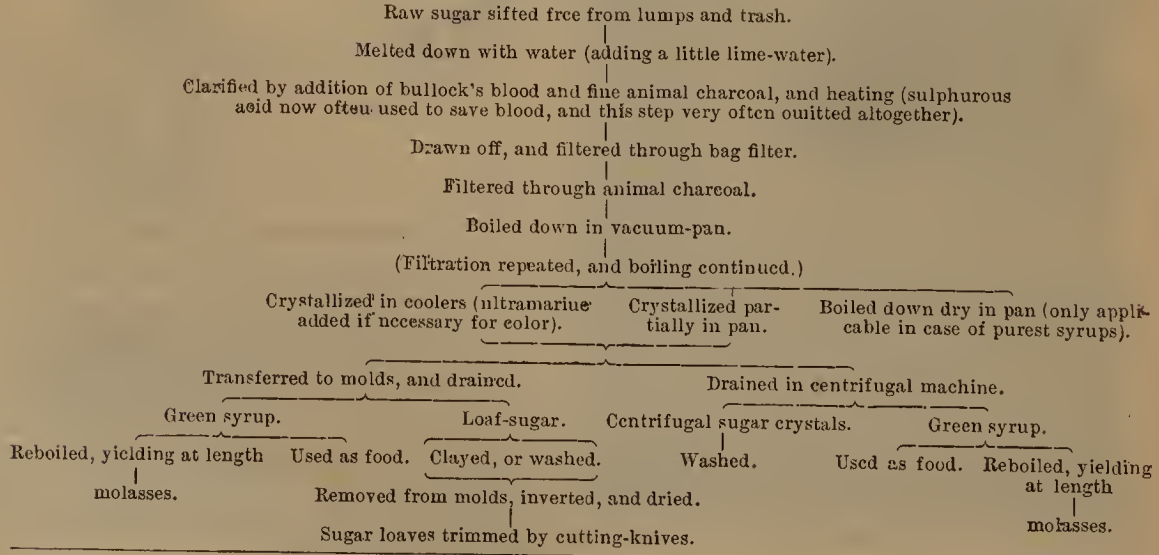
A, is a bench top. *B*, a portion of supporting frame. *C*, a vise frame preferably capable of being swung horizontally about a vertical bolt *V*. *D* represents a movable jaw. *E* the customary wooden shaft of same. *F* is a metal rack fastened in a rebate on under side of jaw-shaft. *H*, a step or bearing in breast-board *G*, for fulcrum *I* of bent lever *J* having treadle projector *j*. *K*, a pawl, which when the lever is forced back by the operator, engages in rack *F*, and operates to press back the sliding jaw *D* with the great accumulating force of a toggle. *L*, a stud to hold pawl clear of rack when lever *J* is in normal or inactive position. *M*, a gravitating catch which, until released, holds lever *J* to its effective or gripping condition.

Sug'ar. For machines and processes, see pp. 2442–2452, "*Mech. Dict.*" J. W. Mallet's report, vol. iv., Group III., Centennial Exposition, summarizes the sugar making process as follows: —

CANE SUGAR.


Canes cut, and stripped of leaves.
Juice expressed from canes.
Canes cut into thin slices or chips by revolving knives.
In presses with intermittent action (reciprocal motion).
In presses with continuous action (roller-mills).
Slices treated with water in a series of diffusion vessels.
Juice.
Bagasse.
Bagasse.
Juice.
Saccharine liquid from diffusion battery.
Exhausted chips (bagasse).
Dried, used as fuel, and the ash as manure.
Returned to field as manure.
Macerated with water, or treated with steam, and again pressed.
Dried in sun, used as fuel, and then ash as manure.
Spread upon land and plowed in as manure.
Exhausted bagasse.
Weak saccharine liquid.
Might well be used as material for paper.
Cleared of fiber by settling in tanks.
Simply evaporated to dryness, producing "concrete," to be afterwards refined.
Liquid heated in clarifying-pans, with addition of lime (often of sulphurous acid, or calcium acid sulphite).
Skimmed.
Skimmed, and run through coarse bag filters.
Clear liquid, boiled down in open pans.
Scum.
Scum.
Clear liquid, filtered through animal charcoal (either now or after partial evaporation).
Used to make rum (often thrown away).
Allowed to crystallize in coolers.
Boiled down (sulphurous acid sometimes added).
Drained in centrifugal machine.
Transferred to potting casks, and drained.
Transferred to forms or molds, and drained.
In open pans.
Partly in open, partly in vacuum-pan.
In vacuum-pan.
Molasses. Reboiled for 2d products, used as food, or to make rum.
Soft centrifugal sugar.
Molasses. Reboiled for 2d products, used as food, or to make rum.
Soft brown sugar (often called muscovado).
Clayed or washed.
Allowed to crystallize.
partially in pan, then
in coolers.
Molasses and drainings. Reboiled for 2d products, used as food or to make rum.
Clayed sugar.
Transferred to forms or molds, and drained.
Drained in centrifugal machine.
Sugar. Washed with a little water or syrup.
Green syrup.
Green syrup.
Sugar. Washed with a little water or syrup.
Used as food.
Form sugar (nearly white).
Drainings.
Drainings.
Centrifugal sugar crystals (nearly white).
Returned to battery, to be reboiled.

SUGAR REFINING. (Cane or Beet.)


Raw sugar sifted free from lumps and trash.
Melted down with water (adding a little lime-water).
Clarified by addition of bullock's blood and fine animal charcoal, and heating (sulphurous acid now often used to save blood, and this step very often omitted altogether).
Drawn off, and filtered through bag filter.
Filtered through animal charcoal.
Boiled down in vacuum-pan.
(Filtration repeated, and boiling continued.)
Crystallized in coolers (ultramarine added if necessary for color).
Crystallized partially in pan.
Boiled down dry in pan (only applicable in case of purest syrups).
Transferred to molds, and drained.
Drained in centrifugal machine.
Green syrup.
Loaf-sugar.
Centrifugal sugar crystals.
Green syrup.
Reboiled, yielding at length molasses.
Used as food.
Clayed, or washed.
Washed.
Used as food.
Reboiled, yielding at length molasses.
Removed from molds, inverted, and dried.
Sugar loaves trimmed by cutting-knives.

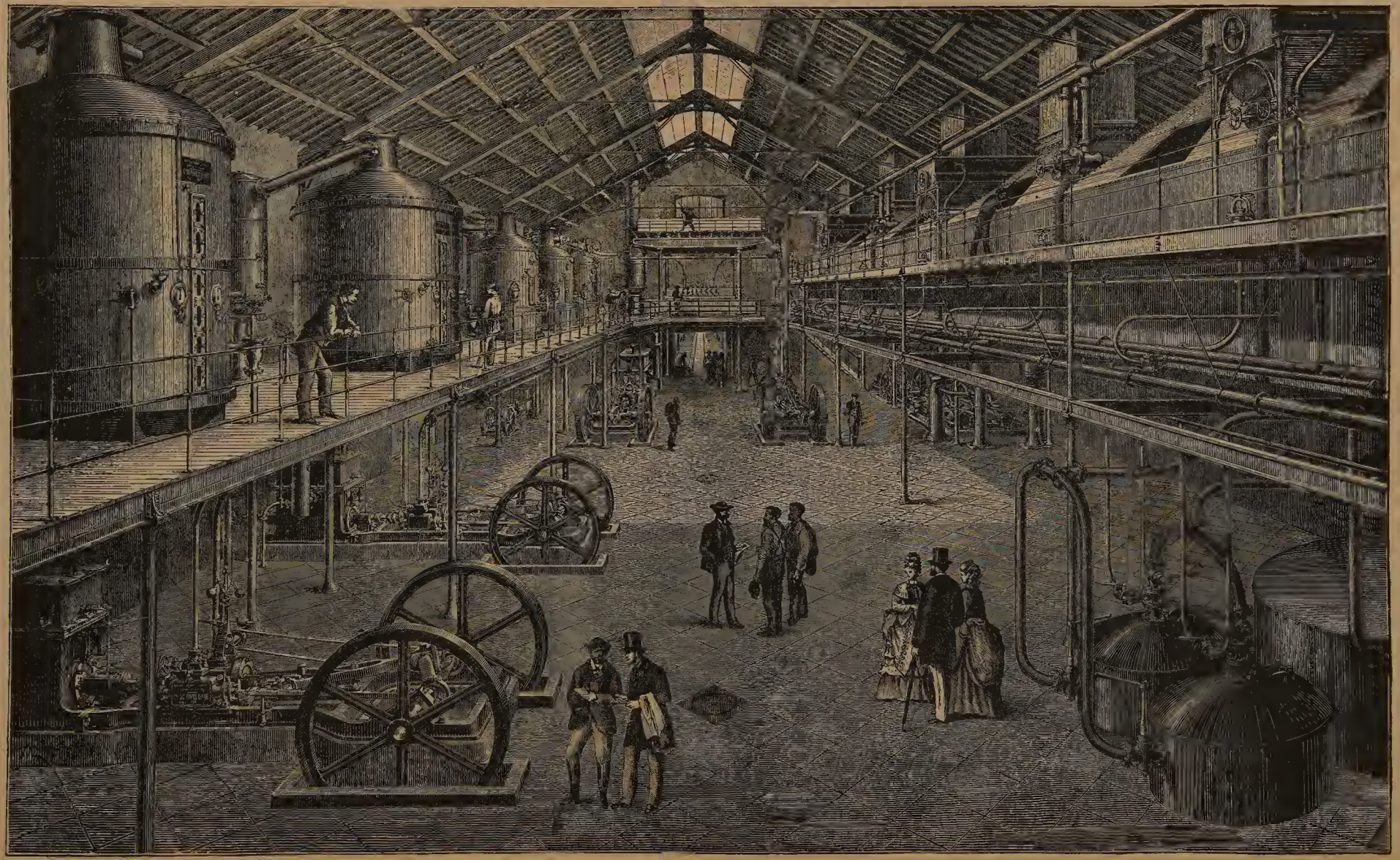


PLATE XLVII. SUGAR-HOUSE, COMPLETE INSTALLATION OF MACHINERY. (COMPAGNIE DE FIVES LILLE, ABBEVILLE, FRANCE.)

See page 873.

Su'gar House. Plate XLVII. represents a complete sugar house as manufactured by the *Compagnie de Fives Lille*, at Abbeville, France.

This company has built apparatus for operating on sugar-cane, for Java, Reunion, Brazil, the West Indies, and Egypt In the latter country one establishment, on account of the Khedive, is adapted to work 1,800 *tonnes* (Fr.) in 24 hours.

In an iron building 11,100 square meters in superficies are arranged —

4 cane mills.
2 vacuum pan apparatus, *à triple effet.*
4 vacuum pans.
60 centrifugal filters.
2 stills and apparatus.
3 rectifiers.

And various accessories for the crystallization of the sugar, fermentation of the molasses, revivification of the animal black, gasworks for lighting.

Repair shops.

A battery of steam boilers of collective force of 2,600 horse-power, to furnish the motive force, and the heat for the apparatus, is heated by the bagasse.

Railways of a total length of 22 kilometers, with the necessary locomotives and rolling stock, bring 250,000 kilos of cane each 24 hours to the mills. The mill has cylinders of 800 millimeters diameter, with an endless apron cane conductor 30 meters long, and a bagasse conductor of 12 meters.

The vacuum apparatus *à triple effet*, similar to the one shown in the far-end of the gallery to the left, in the plate, will concentrate to a density of 29° Beaumé, 2,200 hectoliters of juice per 24 hours. It is composed of three pans of different diameters, with tubular heating coils presenting a total heating surface of 300 square meters. A circumferential distribution of the vapor is secured by means of an envelope of perforated sheet metal interposed between the cluster of tubes and the exterior walls of the vacuum pan. By means of a central vertical tube of large diameter placed in the pan the juice is caused to circulate rapidly, and great activity given to the evaporation by bringing fresh quantities of juice in contact with the heating surface. Systems of pipes and cocks form communication between the juice and the vapor departments of each pan, so that the work proceeds in continuous order in the series of pans upon the juice which flows through them in succession.

An economy of 60 per cent is claimed to be realized in this apparatus over the single acting pan. An aspirator, feeding the first pan of the series, takes the place of the *monte-jus;* a vacuum chamber placed behind the third pan serves as a *reservoir d'aspiration* to a pump which elevates the sirups at 25° B. into the filters ; a tubular condenser has a double action, in condensing a portion of the vapor in the third pan it heats the incoming juice to a temperature of 35° to 40° C. ; the other portion of the vapor is condensed by an injection condenser; the apparatus is completed by a double-acting air pump, an aspirating sirup pump, and a pump for the water of condensation.

The plate shows a complete installation of apparatus for the treatment of beet-root juice for the manufacture of sugar, as manufactured by the *Compagnie des Fives Lille.* The establishments where the beets are rasped and the pulp pressed are situated at a distance, and the juice is conveyed by subterranean pipe-lines to the centrally situated sugar factory ; the system of Linard, as described by Maumené in his "*Traité de la Fabrication du Sucre*," page 207, *et seq.*

The cartage of beet-roots is very heavy and injurious to the roads, and the area of beet culture which can be made tributary to a single sugar factory is not very large, and had been so frequently reached that it became necessary to devise other means of transportation. Hence the pipe-lines of Linard. Since 1867, the year of the establishment of the first pipe-line at Mont Cornet (*Aisne*), having a length of 8 kilometers, beet rasping works have been constructed in increasing numbers and at greater distances. There were in existence in 1875, 240 of these lines. One of them serves a factory 32 kilometers (20 miles) distant.

The juice should be limed at the works, as it cannot without injury be poured into the pipes in its natural condition. One per cent. lime is employed, which is immediately dissolved, and prevents all alteration of the juice in its travel. By the process adopted by Maumené the juice may even be kept several years without injury, and the liming to the extent of 1 per cent. is a modified application of the process. Derosne, about 1811, was the first to suggest quicklime in the purification of the juice, and the lime kiln or furnace, both for the milk of lime used in the preliminary treatment and for the production of gas for the subsequent carbonation of the lime in a subsequent part of the treatment, is a constant feature in the immense *sucreries* which dot the landscape in the northern part of France and the south of Belgium.

After lining, the juice is allowed to repose for 24 hours and then the limpid liquid is pumped into the pipe, which is buried below the line of frost, and reaches from the *râperie* to the *sucrerie*. The pipe may vary from 2.5″ to 5″ in diameter, according to the amount of juice to be delivered, generally along a roadside, where the *cantonnier* can observe any leak, which always shows itself at the surface of the ground. The highest parts of the conduit are provided with air traps to allow air to escape and avoid (*coups de belier*) concussion. See AIR TRAP.

The condition of the juice is verified from time to time, on arriving at the factory, to determine the proportions of lime added.

The advantages of the pipe-line system consist in spreading the work, as the rasping and pressing require a much larger number of men than the subsequent operations, and they are left in their villages near to their work and their fields ; the saving in hauling and deterioration of the roads ; leaving the pulp on the farms for cattle and sheep feed ; the convenience of buying the juice by the saccharometer degree instead of by the weight of the beets of such varying qualities.

The conduit is used about 4 months, the length of the beet-working season.

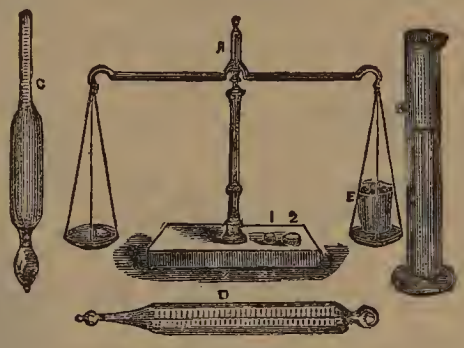
The apparatus shown in the plate will work up the juice of 80,000,000 kilos of beets in a season of three months. It employs carbonating boilers of 300 hectoliters capacity ; the vacuum pan, *à triple effet*, will concentrate 10,000 hectoliters of juice in 24 hours

Su'gar Spile. A spile or spout driven into the sugar-tree to conduct the sugar-water or sap to the bucket. Commonly made of alder, although the iron spile to hang the bucket on is extensively used.

Su'gar Test'er. Apparatus for testing grape sugar.

In using, place the metallic cup, in Fig. 2383, on the scale, and balance it with weight not numbered. Then place the

Fig. 2383.



Sugar Tester.

small weight *1* on the scale, and in the cup *E*, put enough of the sugar you wish to test to exactly balance. Now place the large weight, 2, on the scale, and pour into the cup a small quantity of *warm* water to dissolve the sugar ; when dissolved add cold water enough to balance. Then pour off the solution into the glass jar, and test it with the hydrometer and thermometer. The hydrometer indicates the percentage of saccharine, while the thermometer shows any irregularities or discrepancies of the hydrometer. The degrees below zero on the thermometer (Centigrade) are to be subtracted, the degrees above zero are to be added. Each degree on the thermometer is equal to 1-10° on the hydrometer. For example, the hydrometer indicates 85°, the thermometer 8° above zero. This 8 is to be added to 85, making 85 and 8-10 per cent. If the thermometer should indicate 8 below, it would be necessary to deduct .8 from 85, which would make it 84.2°.

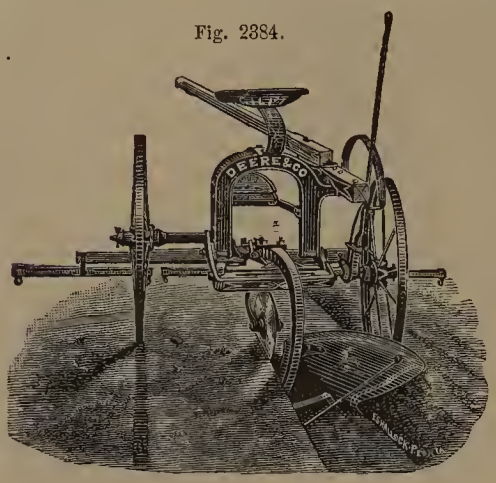
Sul'ky Plow. The Deere & Co.'s Gilpin Sulky Plow, Fig. 2384, is an iron and steel plow with the exception of the tongue and eveners. It is usually drawn by three horses abreast, one horse and one wheel in the furrow.

The team is hitched directly to the end of the plow beam in the natural way, and the plow is operated by a single lever, that locks it in the ground at various depths, so that it cannot jump out on encountering clods and trash.

The sulky plow of the Sacket Plow and Pulverizer Co., of New York, has two plows so arranged and run that one plow skims off the surface sods, stubble, and weeds, and throws them into the bottom of the previous furrow, where they are pressed down and cut by an iron wheel with curved knives, or sharp-edged cross-bars, around its rim.

Following this skim plow is a main plow, which takes up

Fig. 2384.



The Deere Sulky Plow.

the cleared soil to any depth desired, and throws it inside of the iron pulverizing wheel. As this wheel rolls along, the soil is lifted and thrown against its cutting bars and points, and these pare and break it finely, dropping it out loosely behind, putting not an ounce of pressure upon it, but leaving it light and porous and aërated (filled with air).

Sul'phate of Lead Bat'te-ry. (*Electricity.*) The invention of M. Becquerel; consisting of zinc in sulphate of zinc, and lead in sulphate of lead. As improved by Marie-Davy, it consists of a vertical series of tinned iron pans; each pan has a zinc disk fastened beneath it, and is coated inside with pulverized sulphate of lead, moistened with water. The battery is put in operation by pouring water into the pans.

Prescott's "Electricity" . . . . . *79.
Niaudet, American translation . . . . . 150.
Moseley's modification, "*English Mechanic*" . . *xxiv. 463.

Sul'phate of Mer'cu-ry Bat'te-ry. (*Electricity.*) A battery in which sulphate of mercury is the exciting solution. See MERCURY BATTERY; MARIE-DAVY BATTERY.

Beaufil's sulphate of mercury battery has a solid depolarizer. — "*Teleg. Jour.*," * vi. 397.

Sul'phur and Am-mo'ni-a Test. In order to detect ammonia or sulphuretted hydrogen in illuminating gas it is only necessary to allow a jet of the gas to blow upon a piece of turmeric or reddened litmus paper to ascertain the presence of the former, or upon acetate of lead paper for the latter.

Dr. Letheby's sulphur testing apparatus is a meter with dial arranged to show any consumption from .01 to 1,000 cubic feet, a double dry governor fitted with a regulating cock to maintain an unvarying rate of consumption under the usual street pressure, connected to tube passing through the stand, and leading to a Leslie burner, under which stands a glass beaker containing the requisite quantity of standard liquid ammonia. On this beaker is placed a glass funnel passing up through the burner, and covering it is a trumpet-shaped glass tube gradually decreasing to about ¾″ aperture at the top, where it passes through the neck of the large glass cylinder, which has a bent glass tube at the other end rising at an angle of about 45°, the rate of consumption being one cubic foot per hour. An apparatus for ammonia can be supplied with the above, consisting of an ammonia tube, with bulb, etc., at a small additional cost, as the meter and governor can be used — proper connections being made — to pass the gas through the meter "after" the ammonia apparatus.

Sul'phur Con'crete. Mix together 19 lbs. sulphur and 42 lbs. pulverized stoneware and glass. This mixture is exposed to gentle heat until the sulphur melts, when the mass is stirred until it has become thoroughly homogeneous and is then run into molds and permitted to cool. When required for use, it is to be heated to 248° Fah., at which temperature it melts, and may be employed in the usual manner.

At 230° Fah. it becomes as hard as stone, and, it is said, preserves its solidity in boiling water, unites stone, is waterproof, resists acids.

Sul'phu-rine. A new metallic compound. Sulphides of metals, combined with molten sulphur, form a liquid, which on cooling becomes a homogeneous mass of dark gray color and possessing great tenacity, while it is not affected by the atmosphere, and resists acids and alkalies well. It has a comparatively low melting point, 320° Fah., and expands in cooling so that it fills molds very accurately, so well indeed that the marks of a finger on a plate of glass are reproduced. Experiments are being made to test its adaptability for printing and stereotyping purposes, and casts from gelatine molds have been made without destroying them.

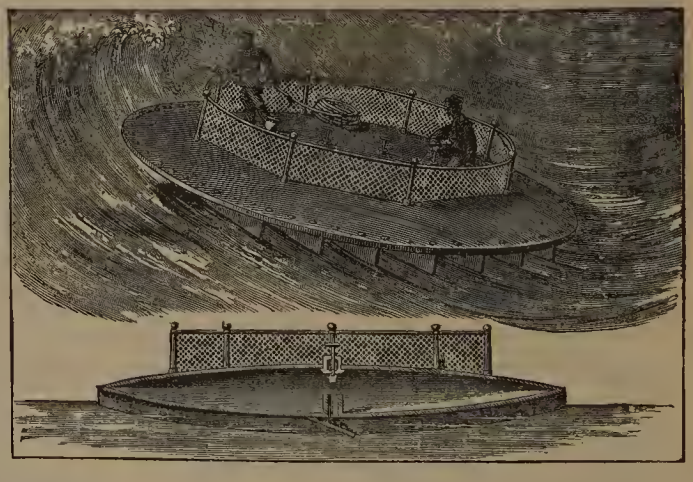
Sump. (*Mining.*) That part of the shaft below the platform used for receiving water.

Sun Burn'er. A burner for a mineral-oil lamp, provided with a chimney that is wide at its base, and held in place by a thin circular metallic plate, cut with indentations around its outer edge, the metallic points acting as springs to hold the chimney in place.

Surf Boat. Fig. 2385 represents a novel surf boat, the invention of Mr. Richard Tucker of Wiscasset. It is a circular boat, with convex upper and lower surfaces, and its entire interior forms a reservoir for holding compressed air to be used in the propulsion of the boat.

The propelling device consists in air nozzles projecting towards the stern, one being placed in each space between the keels, of which there are several. The air nozzles have valves that are operated from the deck. The boat is steered by

Fig. 2385.



Surf Boat.

closing the air valves on one side or the other, as may be required.

Sur'face Con-den'ser. One form of surface condenser is recommended by Appleby, where the supply of water is limited or costly, a good vacuum being stated to be more readily attainable by it than by any other method of condensation. As it is a circulating system in which the boiler is supplied from the hot well, the loss of water from steam passing into the atmosphere is but small, and the saving in the avoidance of scale is a marked advantage in some localities. It is used for steam en-

gines, vacuum pans, and elsewhere, when a vacuum is desirable.

The condenser is a vertical series of horizontal copper steam pipes, with cushion boxes at each end connecting with vertical hollow columns Above is a copper trough with serrated edges, from which water trickles down over the pipes and falls eventually into the hot well from which the boiler is supplied.

The idea has been developed for some time in various branches.

The ordinary tubular condenser, in which the coil is submerged in a cistern of cold water, differs in substantial respects (Fig. 1415, "*Mech. Dict.*"), and the condenser for alcoholic vapors of sugar has also the cistern in which the coil is submerged.

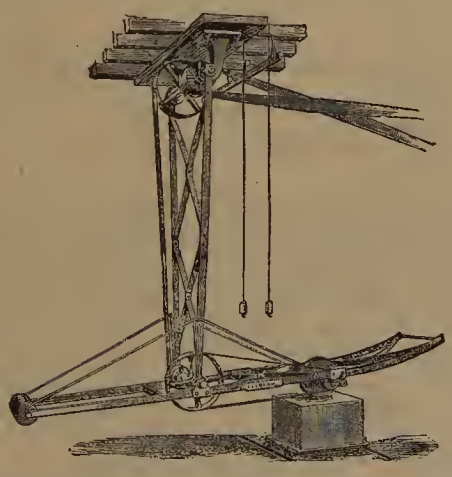
The Derosne condenser, however (Fig. 1421, "*Mech. Dict.*"), one of the train in the sugar apparatus, has the same appearance as the Appleby steam condenser, but their purpose and application are essentially different. In the Derosne the pipes are heated by steam, and the sugar-cane juice from the defecator trickles over them, being heated and partially evaporated on its way to the vacuum pan.

In Appleby's the steam in the pipes is condensed to form a partial vacuum in front of the piston, and the water heated thereby supplies the boiler.

For other systems of pipes in somewhat similar relation, see BEER COOLER, Fig. 631, "*Mech. Dict.*"; LIQUID COOLER, Figs 2966–2968, "*Mech. Dict.*"; WORT COOLER, Figs. 7360–7372, 7364, "*Mech. Dict.*," etc.

Sur'face Grind'ing Ma-chine'. Thomson's surface grinder, Fig. 2386, has, depending from overhead, driving arrangements, constructed to

Fig. 2386.



Thomson, Sterne, & Co.'s (Glasgow, Scotland), Surface Grinding Machine.

grind and buff the surfaces of work too large or heavy to be taken to the ordinary grinding machines.

The illustration, Fig. 2385, shows the machine in position for finishing the exterior of a fire-proof safe, which is run beneath it upon a truck.

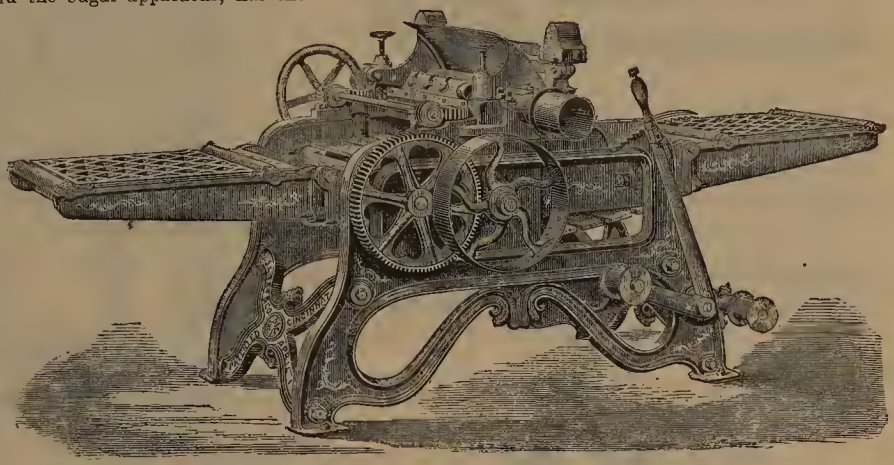
The machine carries a consolidated emery wheel 14″ in diameter by 2″ broad. When required for buffing, the emery wheel is removed and a buff-wheel with spindle and pulley complete put in its place.

The machine carries its own countershaft with fast and loose pulleys. The frame and grinding wheel are balanced by the weight at the opposite end of the frame, so that the operator has easy and complete control in moving the grinder or buffer backward and forward over the work, while the latter is moved sideways on the carriage, which traverses on rails.

Sur'face Mold'ing Ma-chine'. Boult's carver and moulder has a quick, reverse motion and double-edge cutters, cutting designs, either plain or molded, on the surface of the lumber in the solid wood. It molds any production of the scroll saw. It runs for stairs and pew ends, grooves and grounds for inlaying, and veins and traces for carving.

Sur'face Pla'ner. The Farrar surface planer, Fig. 2387, is a machine of a large size, intended for

Fig. 2387.



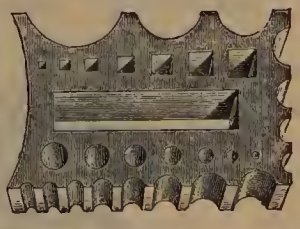
Surface Planer.

planing-mills, boat builders, etc. It has a stationary cylinder, convenient to have the countershaft either on the floor or overhead. It carries three knives with steel-lip chip breakers and steel journals, with pulley for two driving belts running in self-oiling boxes, with a wrought-iron bonnet, that can be swung clear of the cutters. The rollers have folding weighted levers that are self-adjusting to the thickness of lumber.

Sus-pen'sion Ap'pa-ra'tus. (*Surgical.*) To support a wounded, luxated, or fractured limb. Generally a splint with means of suspension from a frame. Illustrations of the following are in *Tiemann's "Armamentarium Chirurgicum,"* Part IV.: —

Smith's anterior splint for the leg, Figs. 120, 154.
Hogden's suspending apparatus, Fig. 130.
Salt's cradle or swing, Fig. 156.
Clark's suspended splint, Fig. 157.
Euck's suspension apparatus, Fig. 174.
Sayre's suspension apparatus, Figs. 193, 194.

Fig. 2388.



Swage Block.

Swage Block. A large perforated and indented iron block for swaging iron into its desired shape. See Fig. 2388.

Swa'ging Mal'let. A tool for swaging up artificial plates. Fig. 2388 represents formers used in silversmith's work.

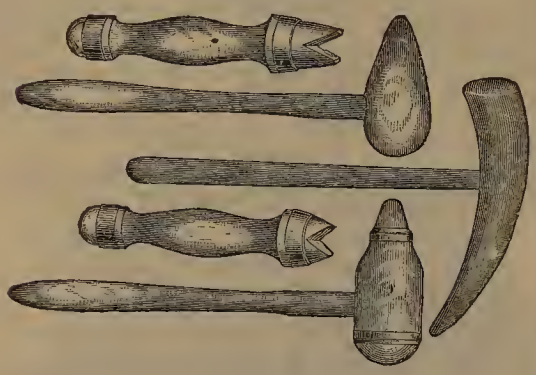
Swan'-neck Nee'dle For'ceps. (*Surgical.*) An instrument for use through curved passages difficult to reach.

Swash Plate. A plate set obliquely on its axis and acting as a cam in a line parallel to the shaft.

Sweat Rol'ling Ma-chine'. A machine for

turning the edge of the sweat-leather lining of hats to prevent its marking or hurting the forehead.

Fig. 2389.

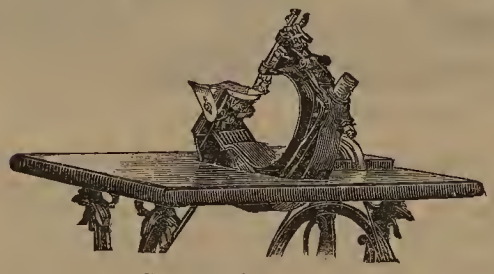


Swaging Mallets.

The machine has two rollers geared together and supported in a frame, the upper one held down by a rubber spring to allow it to yield to the varying thickness of the leather.

Sweat Sew'ing Ma-chine'. A machine for sewing the sweat lining in hats. See Fig. 2390.

Fig. 2390.

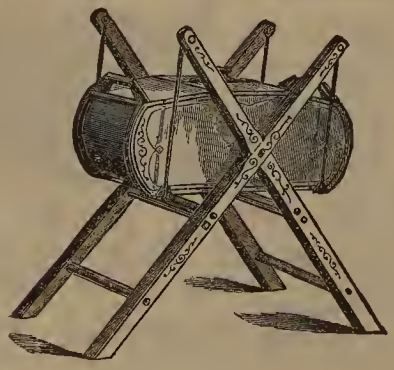


Sweat Sewing Machine.

Sweep. (*Agric.*) A kind of plow used in cultivating crops planted in rows, corn or cotton for instance. The term is especially applied in cotton cultivation, the share or shares being wide and cultivating a wide space to a moderate depth. By the inclination of the share to the line of draft the soil is cast sideways and may throw it either away from the plants while small or towards the row when they are more advanced. See COTTON SWEEP.

Sweep Rake. The rake that clears the table of a self-rake reaper.

Fig. 2391.



Swing Churn.

Swing Churn. A box churn suspended on the pivoted bed irons of the folding frame on which it swings. See Fig. 2391.

Swing'ing Valve. A swinging straightaway check valve. The clapper swings on a pin loosely, and the disk being made separately can be ground in the same as other valves.

Swing Mo'tion Gear. (*Railway.*) The arrangement of parts, — consisting of bolster, spring-plank, swing-hangers, pivots, and pins, — supporting the springs and truck-bolsters by which a car is enabled to swing laterally on the truck.

Swing Saw. The swing cut-off saw is used for cutting up stuff for packing boxes, etc. It has counter shaft, hangers, and pulleys.

Switch. For descriptions of switches, crossings, turn-outs, and frogs on Pennsylvania Railroad, see report of *F. Slataper*, "*Centennial Exhibition Reports*," vol. vi., Group XVIII., p. 68.

Switch'ing Eye. (*Railway.*) A cast-iron socket on the corner of a freight car to which a chain or push bar may be applied by an engine on an adjoining track.

Switch-ing-in' Plug. (*Electricity.*) A plug having its two brass sides insulated from each other by a strip of hard rubber and provided with a handle of the same material. The sides are adapted by binding screws to be connected respectively with the terminals of a loop or relay circuit so that when thrust into a plug-hole the two sides of which are similarly insulated and connected with the line terminals, the said loop and line will be in one circuit.

Fig. 2392.

Switching-in Plug.

Switch Ta'ble. The Jones (Fig. 2393) is a telephone exchange switch board or table through which all the subscribers can at any time communicate with each other. It is composed of the following component parts : —

Plug plates.	Telephone lever switch.
Plug connectors with flexible cords.	Generator of electric current.
Drop or electrical indicator.	Treadle.
Spring jack.	Plug sockets.
Engine or generator key.	Key board.
Telephone key.	

See TELEPHONE.

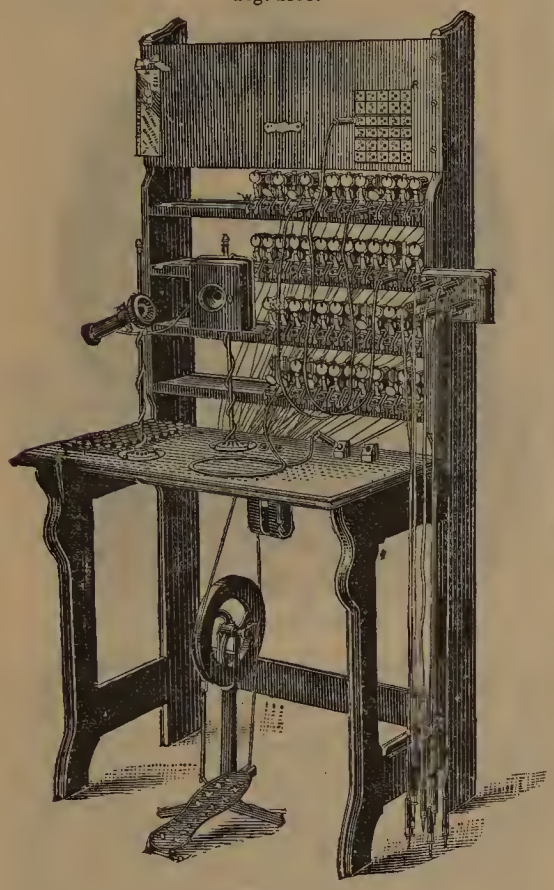
From the instrument of every subscriber in the city a wire is run to the exchange. When a subscriber wants to talk to any other subscriber, he calls up the Exchange by ringing his bell. The Exchange answers, finds out what he wants and who he wants to talk to, calls up that person, and connects or "switches" their wires together; then signals to subscriber No. 1 that he can go ahead and converse with No. 2, and leaves them to talk together as long as they please. When they are through, they signal to the Exchange, and he disconnects them. When it is stated that the average number of "switches" made in the twenty-four hours, in Cincinnati, is 6,000, it will be seen to what an extent the business has grown.

The "switch" tables, of which there are twelve in the Cincinnati Exchange, are in form of a common writing table, with a square frame standing up in front of the operator and fastened to the table. To this frame run the wires brought into the office through the cupola, each one of which is ticketed with the name of the subscriber to whose instrument it is attached.

In each frame are from forty to fifty magnets to which these wires are connected. These act as holders for the wires, and are numbered. Thus one end of each subscriber's wire is attached to the instrument in his office or home, and the other is fastened to this frame or the switch-board. The operator at every board knows the number of each subscriber. On the front of the frame facing the operator are a number of clamps, one to each magnet. There is also attached to each magnet a movable piece of metal, which works automatically. This is the marker, which tells the operator which line calls him, as it drops when the bell at the other end of the line is rung.

Underneath the table is a machine worked by a treadle, which generates the electric current by friction, and is con-

Fig. 2393.

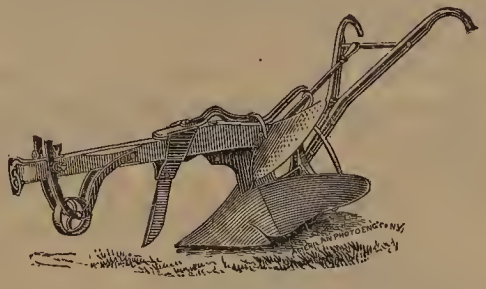


Switch Table.

nected by a wire with a clamp on the table On the table is a key-board, like the key-board of a type-writer. It contains two large keys and a number of small ones corresponding to the number of wires on the frame. One of the large keys is connected with the generator and the other with the telephone, which is fixed on an upright fastened to the table within reach of the operator's ear, leaving him at liberty to use both hands. Hanging on a hook within reach of each table are a number of loops or sections of flexible covered wire with a brass point at each end. This, with a microphone, also on the table, is the apparatus. Now as to how it is used We will, to illustrate, take the first table, on which the connecting wires are numbered from 1 to 40. Suppose Mr. A. has the telephone No. 1 and Mr. B the telephone No. 25, and that A wants to talk with B. He goes to his instrument and rings the bell. At that instant the little marker attached to wire No. 1 in the Exchange rattles and falls, attracting the operator's attention. He has one of his loops attached by one point to the clamp on his table connected with the generator and as soon as he gets the call takes the other point and inserts it in the clamp attached to wire No. 1, thus connecting the latter with the generator. At the same time he works the treadle and generates a current of electricity, which, by pressing on one of the large keys, he directs into wire No. 1. At the instant he presses this key the current passes over the wire and rings A's bell. The operator slips his finger to the other large key, and applying his ear to the telephone, and speaking at the microphone, says, "Hello!" A, when he hears his bell ring, takes his telephone in hand, and, applying it to his ear, hears the "hello," and calls to the operator, "Put me on Mr. B," or "Connect me with Mr. B." The operator answers, "All right," and proceeds to call up B by directing a current of electricity from the generator through a loop, the point of which he has inserted in the clamp connecting with B's wire. This current rings B's bell. He goes to his instrument, rings back an answer, his marker rattles and drops, and the operator, connecting his telephone with B's, as he did with A's, calls to him that A wants to talk with him. He then connects the two wires, 1 and 25, together by means of a loop, the opposite points of which are in the two clamps connected with their wires. This forms a continuous wire between the telephones of A and B, and the operator, having called to A — who has held his telephone to his ear — that B is ready, they go on with their conversation. By pressing either key No. 1 or key No. 2 on the key-board and keeping his ear at the telephone the operator can hear their conversation. He listens for a moment to satisfy himself that their communication is uninterrupted and then takes his finger off the key. When A and B are through they inform the operator by tap of the bell and he takes away the loop connecting their wires, disconnecting them. Though the operation takes some time in describing, it is very quickly done, not occupying more than a minute if the owners of each telephone are prompt in answering his call. The only delay is with them. The operator is always at his post, and can switch two parties together in a few seconds if they answer as soon as called.

Swiv'el Plow. A reversible mold-board of full size is so arranged on its swivel attachment that in connection with the point it makes also a landside plow. See Fig. 2394.

Fig. 2394.



Swivel Plow.

Swiv'el Ta'ble Clamp. One intended for the attachment of jeweler or amateur vises, without injury to the article to which they are attached. With it the vise can be clamped firmly to any kind of table, mantel, or projection.

Sword Mat. (*Nautical.*) A mat worked with a blade like a sword to drive home the roving threads. It is made with shoulders to protect the lanyards of lower rigging, boats, gripes, etc.

Sym-pal'mo-graph. An instrument for making Lissajou's sound curves. — "*English Mechanic*," * xxv. 18.

Syr'inge. See Injector.

Syr'inge Gun. A tube with piston, ejecting water for disabling humming birds without destroying them.

T.

Ta'ble Brush. (*Leather.*) A soft brush used by curriers to sweep shavings from the buffing table.

Taf'fe-tas Ar'mure. (*Weaving*) One of the four principal characters of weaving. See Armure.

This is a simple form of weaving, having but two harnesses, simply interlacing the threads of the warp and weft.

This is the *weave* of broad-cloth, cotton shirtings and sheetings and *mousseline de laines*.

The variations in the goods are cited under Fabric.

Take Up. (*Weaving.*) 1. The web roller on which the cloth is wound.

2. The device on a sewing machine for taking up the slack of the thread on the upward stroke of the needle.

Take' Up Mo'tion. (*Weaving.*) A device for automatically winding the tissue on to the cloth beam.

See English form, "*Scientific Amer. Supplement*," * 4091.

Talk'ing Ma-chine'. During more than a

century inventors have turned their ingenuity to constructing machines capable of imitating the human voice, though what practical purpose they might serve, if ever so perfect, it is difficult to discover. One of the latest of these efforts is a machine made by M. Faber.

It consists essentially of three parts, — the wind-producing system, the sound making apparatus, and the articulating arrangement. As for the first, nothing particular need be said; it is simply a species of bellows. The second, the sound-producer, the laryux, is an ivory tube so constructed that within certain limits the length may be varied so as to cause a difference in tone produced. Probably it would have been more successful had some more elastic material been adopted. The articulating apparatus includes a part for sounding the vowels, and another for pronouncing the consonants. The former are due to the passage of air through openings of different shapes, made in diaphragms placed successively in the current of air by the action of levers moved by the fingers; in addition, a special cavity, destined to produce nasal sounds, can be put in communication with the former at pleasure by means of a particular lever. The consonants are produced by pieces, the action of which is analogous to that of the lips, the teeth, and the tongue, and the rolling of the *r* is caused by a wheel. All these imitation organs are put in motion by 14 keys very ingeniously disposed in a way to produce the necessary intensity of action and variation in sequence of the parts destined to pronounce a syllable. The number of 14 keys is sufficient, for by certain variations in the touch the intended sound can be regulated as strong or weak at pleasure. As might be expected, the language of the machine is very monotonous, and is by no means perfect, as some sounds produce a much better effect than others; however, in general, the words pronounced are easily understood. They cannot be compared to the changes in the human voice, and whatever improvements the machine may receive, the question still remains, Of what use is it?

Talking Machine, *Faber* . * "*Scientific American*," xlii. 266.

Ta'mise. (*Fabric.*) An all-wool French goods.

Ta'mise Rep. (*Fabric.*) A corded all-wool French goods.

Tam'pon. (*Surgical.*) *a.* A plug to arrest nasal hemorrhage. See EPISTAXIS.

b. An inflatable plug inserted in the trachea to prevent blood from entering the lungs while the surgeon is operating on the throat above the instrument, the lungs being supplied with air through a silver tube.

Trendelenberg's, Fig. 391, Part II., *Tiemann's* "*Armamentarium Chirurgicum.*"

Tam'pon Screw. (*Surgical.*) An instrument with a screw-end to engage and insert or withdraw a tampon or compress to prevent hemorrhage.

Sims', Fig. 468, Part III., *Tiemann's* "*Armamentarium.*"

Tan'dem En'gine. A steam engine in which the two cylinders are placed in line, one in front of the other, tandem fashion.

See COMPOUND TANDEM ENGINE.

Escher Wyss et Cie. . . . * "*Engineer*," xlvi. 23.
Kingdon . . . . . * "*Scientific Amer. Sup.*," 3848.

Tan'gent Gal'va-nom'e-ter.

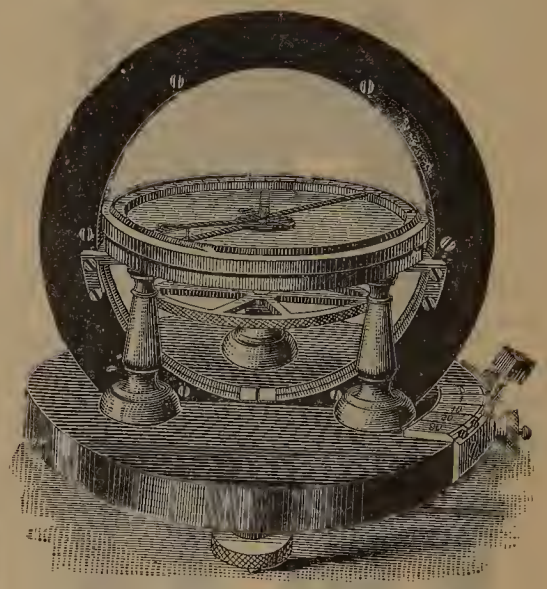
The Western Union standard tangent galvanometer, Fig. 2395, is mounted on a circular hard rubber base provided with leveling screws. It consists of a magnetized needle suspended at the center of a rubber ring, containing the coils. The coils are five in number, of the resistances, 0, 1, 9, 40, and 150 ohms (=200). The first is a stout copper band of inappreciable resistance; the others are of different sized copper wires, carefully insulated.

The five terminals have plug-holes marked respectively 0, 1, 10, 50, and 200. The plugs inserted at the end of the terminal marked 200, puts in circuit all the coils; at the terminal marked 50, all except the 150 ohm coil; and so on till at the zero terminal only the copper band is in circuit.

An aluminum pointer is fixed to the needle at right angles, extending across a 5″ dial. On one side the dial is divided into degrees, on the other it is graduated, the figures of the scale corresponding to the tangent of the angles of deflection. The needle is suspended by a jewel and points.

In the base of the instrument are three resistance coils, of German silver wire, of 10, 500, and 5,000 ohms, having terminals and plugs.

Fig. 2395.



Tangent Galvanometer.

A tangent galvanometer has been recently introduced by Louis Schwindler. The galvanometer has two coils, — one of thick wire and few convolutions, offering no more than 1 ohm resistance; another of thin copper wire, having a greater number of convolutions, and resistance of 100 ohms. Two sets of resistance coils for use with the above coils, respectively, one of 20 and 200 ohms, the other of 1,000 and 2,000 ohms. A simple reverser allows the readings of the galvanometer to be taken from either side of zero. In order that the strength of the currents passing through the coils may be as nearly as possible proportional to the tangents of the deflections, the magnet has a length of less than one fifth of the diameter of the deflecting coil. The small magnetic needle carries a thin aluminum pointer fixed in the right angle of the needle. In order that the needle after each deflection may come sooner to rest, the aluminum point carries small wind fans of the same metal. When closing the box the needle is taken off its pivot.

Tank Lo-co-mo'tive. A form of tank locomotive invented by M. N. Forney, of the "*Railroad Gazette.*" It is adapted for narrow gage. The tender end of the frame is carried on a 4-wheel truck; differing in this respect from the plantation locomotive, which has a 2-wheel truck in its larger forms, and is destitute of a truck in the smaller engines, which are supported on 4 wheels only.

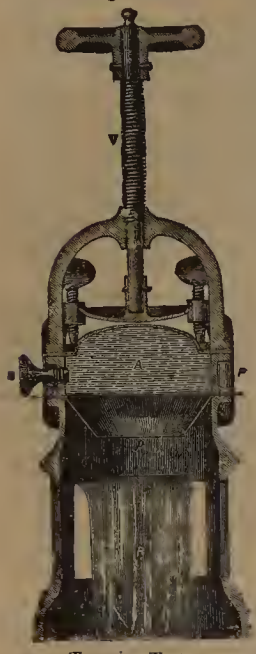
The Forney locomotive resembles the usual passenger and freight narrow-gage locomotives modified by connecting the engine and tender in one rigid frame.

Tan'nin-test'ing Ma-chine'. Fig. 2396 represents the "Muntz" apparatus for testing the efficiency of any tanning solution or material. The principle involved consists in forcing a solution containing tannin through a piece of hide. The density of the solution is taken before and after the operation, and a comparison of the densities enables the value of the solution to be readily determined.

The figure shows the internal arrangement. Having taken a small piece of raw hide, and placed it inside, on the base of the apparatus, the india-rubber cover is closed down over it, and secured by the screws in the claws. The liquid to be tested is then poured in on the top of the piece of hide through the small opening, which is fitted with a screw stopper, *B*. This done, pressure is brought to bear by turning the perpendicular main screw *V* at the bottom of which is attached a brass disk, which gradually compresses the india-rubber cover, and forces the liquid to filter through the hide. The screw must be tightened up occasionally so as to maintain the pressure. A glass is placed beneath the machine to receive the liquid, which percolates drop by drop. When sufficient has been obtained to fill a small test glass, the density is taken. To do this the glass should be filled with the

first liquid kept in reserve, and the tannometer inserted. In a few minutes it will become steady, and the degree is then noted. The same process must be repeated with the filtered liquid. The difference of degrees between the two densities shows the percentage of tannin in the analyzed substance. This difference is multiplied by 40 if 2½ per cent of stuff is put into water; by 20, if 5 per cent; by 10, if 10 per cent; and by 5, if 20 per cent. For instance, if the tannometer marks for the first liquid 2.8, and for the second 1.3, the difference, 1.5, or 1½°, must be multiplied by 40 if we have taken 2½ per cent., which gives 60 per cent. of tannin; by 20 if we have taken 5 per cent., which gives 30 per cent. of tannin; by 10 if we have taken 10 per cent., which gives 15 per cent. of tannin.

Fig. 2396.



Tannin Tester.

The tannometer referred to is practically a hydrometer, which is supplied with the instrument. With it were detected the valuable properties of *balsamo carpon*, which, when gathered ripe, and the gum taken off free from the fiber of the pod, contains 80 per cent. of tannic acid. It is this gum which weights the leather. Gall nuts are liked by the tanners, but it is now found that the property of gallic acid is to open the pores and allow the other weighting materials to enter the hide. With this small machine, tanners and chemists can test the bark from different trees, some of which are known to yield tannic acid, and are employed for the manufacture of ink and dye, but have never been used for tanning leather. The hide takes from the solution all the properties it requires when the substance is filtered.

Tannin extract factory . "*Scientific American Sup.*," 1603.
Testing appa., *Muntz*. * "*Scientific Amer.*," xxxiv. 355.
Muntz, Br. . . . . * "*Engineer*," xli. 171.
Tannic acid extractor.
Thomson . . . . . * "*Scientific American Sup.*," 144.

Tar'get. 1. A signal used at railroad crossings and switches. See SIGNALS.

2. A shield used for proof of heavy guns.

Shoeburyness, Britain, *Report of Cols. Barnard and Wright, U. S. Engineers, Fabrication of iron for defensive purposes, Supplement, No. 21.
Targets of 100-ton gun * "*Scientific Amer.*," xxxvi. 150.
Tangent galvanometer.
Obach, Br. . . . . * "*Engineering*," xxviii. 351.

Tas'e-om'e-ter. Invented by Steiner, of Vienna, for measuring the strains of structures.

It depends upon the tone given out by a wire or strip when stretched. The wire being attached the variation in length of the bar causes a change in the tone. "*Telegraphic Journal*," vi. 126.

The strain measurer of M. Clevenad, of Paris, is figured in the "*Annales des Ponts et Chaussées*," and is designed to measure directly the strains to which the different parts of any structure are submitted. See STRAIN MEASURER.

See TESTING MACHINE.

Ta-sim'e-ter. A device for measuring very minute variations of temperature.

It is founded on the property, discovered by Edison, that lampblack, when pressed in the form of a button, affects the electric currents passing through the same, and offers a resistance, which diminishes with the pressure, and so sensitive is it that when this pressure varies to the amount of only one millionth part of an inch, the variation in the electric current passing through it will cause a variation in the deflection of the galvanometer needle, and this variation will be in proportion to the pressure. Thus, for instance, if the carbon button is pressed by a strip of vulcanite, and the warm hand is held at a distance of 4″ from it, the expansion by heat of this strip, and the consequent increased pressure, will cause an increase in the conductibility of the carbon, and the electric current which previously passed through and made the galvanometer deflect a certain number of degrees, will cause a greater deflection. The same will take place when a gas flame or a match is ignited in the room, even at a distance of 4′. If a strip of gelatine is used to press the carbon button, its expansion by moisture will be indicated in the same way, when a piece of moistened paper or a wet finger is held at a distance of 4″ or 5″; the heat of a lighted cigar, drying the gelatine, will cause it to contract again. diminished pressure is the result, the current passing through the carbon undergoes greater resistance, and the deflection of the needle will be in the opposite direction.

This instrument is an outgrowth of Edison's experiments with that form of the telephone with which he tried to vary the intensity of electric waves by means of the voice. It promises to be a most important addition to the delicate instruments for measuring very minute variations of temperature.

Thus far the most delicate instrument known to science for determining, for instance, the heat in the different parts of the solar spectrum, has been the thermopile. This instrument is based on Seebech's discovery that when metals of different kinds are jointed together, and the joint is heated, an electric current is produced, passing from one metal to the other. By multiplying the joints and connections of the metals, after the principle of a galvanic battery arranged for very great intensity, very small variations of temperature can be observed by the electric currents generated, and their action upon the magnetic needle of the galvanometer. The great superiority of the tasimeter over the thermopile may be illustrated in a simple manner. If a few inches from the former a hot iron is placed, it will deflect the needle of an ordinary galvanometer say one degree; holding the warm finger 4″ from the tasimeter with the same galvanometer, will swing the needle round some six degrees.

The applications, actual and projected, of the instrument are numerous: —

To warn vessels of the approach of icebergs by exposure to the air or to the water cooled by their vicinity.

To indicate otherwise inappreciable weights, as such laid on the apparatus will affect it.

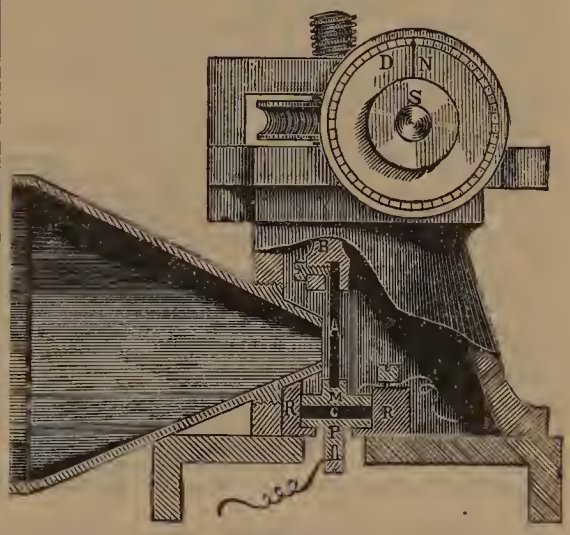
To record pressures of air in motion; affording a delicate and useful addition to the anemometer.

"*Manufacturer & Builder*," x. 149; *Prescott's* "*Speaking Telephone*," etc., * p.?

Fig. 2396 shows in perspective the latest form of the Edison tasimeter. See also MICROTASIMETER.

Tasimeter . . . . "*Scientific American*," xxxix. 143.

Fig. 2397.



Tasimeter.

Tast'ing Hole. A hole in a cementing furnace at which trial bars are left to protrude in order to permit examination of the condition of the process.

The same term is applied to holes in other furnaces left for examination of contents.

Taw'ing. Tanning a lamb-skin with the wool on it.

Make a strong soapsuds, using hot water; when it is cold wash the skin in it, carefully squeezing it between the hands to get the dirt out of the wool; then wash the soap out with clean, cold water; next dissolve alum and salt, of each half a pound, in a little hot water, which put into a tub of cold water sufficient to cover the skin, and let it soak in it over

night, or 12 hours; now hang the skin over a pole to drain; when well drained spread or stretch carefully on a board to dry. It need not be tacked down if drawn out several times with the hand while dryiug. When yet a little damp, sprinkle pulverized saltpeter and alum (an ounce each mixed together) on the flesh side, rubbing it in well. It is now to hang in the shade two or three days, the flesh side in, until perfectly dry. When entirely dry, scrape the flesh side with a blunt knife to remove any scraps of flesh. Trim off all projecting points, and rub the flesh side with pumice or rotten stone, and with the hands. Prepared in this way it is white and beautiful, suitable for a door-mat, and also nice for the feet in a sleigh or wagon iu cold weather.

Teem'ing. Pouring; as for instance, the weighing of steel ingots during teeming, that is, while running into the mold.

See apparatus of *Ferdinand Moro*, Kladno Iron Works, Austin,* "*Engineering*," xxx. 270.

Tel-au'to-graph. An electrical device for transmitting autographs, or copying designs.

An ingenious application of the same general principles as Morse's telegraphic alphabet. A message is written by the sender in an ink which does not conduct the electric current, and the paper is placed in such a position that a style, or metallic pencil, drawn by machinery across the sheet, covers it with an iufinite number of lines, drawn so closely as at first sight to produce the effect of almost continuous coloring, the letters remaiuing uncolored. Whatever is done at one end of a telegraphic wire can be repeated with ease at the other, and a *facsimile* of the original is inscribed simultaneously, and by the same means, at the receiving station. Thus, an autographic message with recognizable signature — or a telegraphic check — may be instantaneously transmitted by any telegraph fitted with the proper apparatus. This system is actually employed on at least one Italian line, and it seems somewhat strange that, considering its extreme simplicity and the great convenienec of a recognizable autograph, the use of such a process has not become more general. The possibility of deception and the impossibility of automatic unquestionable record, such as the copying-press gives to letters, greatly restriet the use of the ordinary telegraph by men of business; and both inconvcniences are removed, it is said, by the employment of telautography.

Te-lec'tro-scope. An apparatus for reproducing by telegraph the images obtained in the camera obscura. This apparatus is based on the property possessed by selenium of offering a variable and very sensitive electrical resistance according to the different gradations of light.

The apparatus consists of an ordinary camera obscura, containing at the focus an unpolished glass, and any system of autographic-telegraphic transmission; the tracing point of the transmitter intended to traverse the surface of the unpolished glass, will be formed of a small piece of selenium held by two springs acting as pincers, insulated and connected, one with a pile, the other with the line. The point of the selenium will form the circuit. In gliding over the surface, more or less lightened up, of the unpolished glass, this point will communicate, in different degrecs, aud with great sensitiveness, the vibrations of the light. The receiver will also be a tracing point of blacklead or pencil for drawing very finely, connected with a very thin plate of soft iron, held almost as in the Bell telephone, and vibrating before an electromagnet, governed by the irregular current emitted in the line. This pencil, supporting a sheet of paper arranged so as to receive the impression of the image produced in the camera obscura, will translate the vibrations of the metallic plate by a more or less pronounced pressure on that sheet of paper.

Tel'e-graph. The following is the chronology of the telegraph.

TELEGRAPHS BY ELECTRICITY.

1774. — Georges Louis Lesage, Geneva, set up the first telegraph line, which consisted of 24 insulated wires for the alphabet, each terminating in a pith-ball electroscope, duly lettered, for iudicating by its excitation the succession of letters in the message, the transmitting operator using a manual conductor from an electrical machine.

1787. — Mons. Lomond, Paris, employed a single brass wire in connection with pith-ball electroscopes, making use of an alphabet of motious.

1794. — M. Reiser, Geneva, used 36 insulated wires for letters and numerals, in connection with a like number of narrow strips of tin foil pasted on glass; the letters and figures were cut iu the foil and made visible by the passage of the electric spark.

1795. — Tiberius Cavallo, England, sent explosive and other electric signals through fine insulated copper wire, using Leyden jars, and sending "sparks at different intervals according to a settled plan."

1798. — D. F. Salva, Spain, worked an electric telegraph through the unprecedented distance of 26 miles, using a single wire, and the sparks of a Leyden jar for signals.

1816. — Francis Ronalds, England, constructed an experimental telegraph line, of a single insulated wire 8 miles long, operated by an electrical machine, or small Leyden jar. Ilis elementary signal was the divergencc of the pith-balls of a Cauton's electrometer, produced by the communication of a statical chaigc to the wire. Lettered dials, rotated synchronously at each end of the line, served, in connection with the pith-balls, to indicate the letter designated by the sender. This dial system was the precursor of Wheatstone's dial telegraph in 1839; House's letter printing telegraph in 1846; and Hughes's printing telegraph in 1855.

1828. — Harrison Gray Dyar, Ameriea, constructed a telegraph on Long Island, supporting his wires by glass insulators fixed on trees and poles; the electric signals printed themselves upon litmus paper, the spacing of the marks indicating the letters and other signs. Just as Dyar and his partner Brown were seeking capital to set up a line between New York and Philadelphia, a black-mailing agent, failing to extort the concession of a large share in the enterprise, obtained a writ against the two partners on a charge of conspiracy to carry a secret communicatiou between the cities! The case was never brought to trial, but the enterprise was blocked.

According to Steinheil, these various experiments put it beyond a doubt that frictional electricity might be made a successful means of telegraphie intercourse.

TELEGRAPHS BY GALVANISM.

1808. — The first to apply to telegraphy the galvanic battery introduced by Volta, in 180 , was Dr. Samuel Thomas Von Soemmering, of Munich. He employed the energy of a powerful voltaic pile to bring about the decomposition of water by means of 35 gold pins immersed in an oblong glass trough. Each of these electrodes was in connection with one of the 35 wires forming the line. The bubbles evolved at these electrodes were received in lettered and figured tubes, and the messages were thus spelled out. In 1810 Soemmering telegraphed through two miles of wire.

1816. — Dr. John Redman Coxe, of Philadelphia, suggested a system substantially the same as Soemmering's (of which he appeared to be ignorant). He also proposed to accomplish the same result by decomposing metallic salts, as was afterwards done.

1843. — Mr. Robert Smith, Scotland, devised a galvano-chemical telegraph carrying out practieally the suggestion of Dr. Coxe. At first he used a separate wire for each letter, the message being printed on a strip of paper wet with a solution of ferrocyanide of potassium. Subsequently Mr. Smith reduced his line to a single circuit of two wires, and worked his system through 1,800 yards of fence wire (1846).

1846. — Mr. Alexander Bain, Scotland, patented in England a galvano-chemical telegraph diffcrent in mechanical details, but similar in its chemical record to the system of Smith.

1849. — Prof. Samuel F. B. Morse, New York, patented in this country a telegraph similar to Smith's.

TELEGRAPHS BY GALVANO-MAGNETISM.

1820. — Hans Christian Oersted, Copenhagen, rediscovered the directive influence of a galvanic conductor on a magnetic needle (Romagnosi's observations of the same in 1802 having attracted no attention). The same year (1820) Professor Schweigger, of Halle, made the first real galvanometer; and shortly after Ampère, in Paris, proved experimentally the feasibility of an electro-magnetic telegraph, in which the galvanometer should take the place of the electrometer employed by Lesage.

1823. — Baron Paul L. Schilling, of Cronstadt, Russia, practically applied Ampère's suggestion. In his apparatus signals were produced by five galvanometer needles, provided with independent circuits.

1824. — Peter Barlow, England, experimenting with considerable leugths of wire, to test the practicability of Ampère's suggestion, was convinced that it was impracticable, owing to the rapid diminution of effect (due to increased resistance), by lengthening the conducting wire. Other inconclusive experiments in the same direction were made by Fechter in 1829, and Ritchie in 1830.

1833. — Prof. Carl Friedrich Gauss and Wilhelm Edward Weber constructed at Gottingen a galvanometer telegraph of a single circuit of uninsulated wire a mile and a half long. The alphabet of signs was made up of right and left deflections of the needle, observed by reflections from a small mirror. Gauss was the first to employ magneto-electricity in telegraphs. Weber added to the sigualing device a delicate apparatus for setting off a clock alarm.

1836. — Prof. C. A. Steinheil, of Munich, undertook, at the

request of Gauss, the development of the arrangement above described, and constructed a similar galvanometer telegraph line two miles in length, introducing considerable improvements. The next year Steinheil discovered that the ground might be made a part of the circuit, thus dispensing with a second wire for the return circuit.

1837. — Mr. William Fothergill Cooke and Prof. Charles Wheatstone patented in England a galvanometer or needle telegraph very similar to the earlier one of Schilling, employing six wires and five indicating needles. An experimental line a mile and a quarter long was worked with partial success July 25; and one thirteen miles long was established in 1838.

While these experiments with the needle were going on the electro-magnet was being developed and applied.

1820. — The germ of the electro-magnet was discovered by Arago, who observed that the electric current would develop magnetic power in strips of iron and steel.

1824. — William Sturgeon, England, produced the true electro-magnet with its intermittent control of an armature.

The electro-magnet of Sturgeon was improved by Professor Henry in 1828; and in 1829 he exhibited a larger magnet of the same character, tightly wound with 35′ of silk covered wire. A pair of small galvanic plates, which could be dipped into a tumbler of diluted acid, was soldered to the ends of the wire, and the whole mounted on a stand. This was the first magnetic spool or bobbin. This invention was further improved the same year, and in 1830 Professor Henry, assisted by Dr. Philip Ten Eyck, constructed an electro-magnet which lifted 750 pounds. In 1831 he made one weighing 82½ pounds, which sustained over a ton. In the meantime Professor Henry practically worked out the differing functions of quantity and intensity magnets, and experimentally established the conditions required for magnetizing iron at great distances through long conducting wires. This first made the electro-magnet available for telegraphic purposes.

1831. — The transmission of signals through a mile of copper bell wire interposed in a circuit between a small Cruikshank's battery and an intensity magnet — a practical telegraph — was practiced by Professor Henry.

"This memorable experimental telegraphic arrangement involved three very significant and important novelties. In the first place, it was the first electro-magnetic telegraph employing an 'intensity' magnet capable of being excited at very great distances from a suitable 'intensity' battery. . .

"In the second place, it was the first electro-magnetic telegraph employing the armature as a signaling device, or employing the *attractive* power of the intermittent magnet, as distinguished from the directive action of the galvanic circuit. That is to say, it was, strictly speaking, the first magnetic telegraph.

"In the third place, it was the first *acoustic* electro-magnetic telegraph."

Further on Mr. Taylor pertinently remarks that it is suggestive to consider how different would have been the popular estimate of Professor Henry's labors if he had been worldly-wise enough to secure an early patent on these three indisputably original and most pregnant features of telegraphy.

1837. — Prof. Samuel F. B. Morse devised a magneto-electric telegraph capable of transmitting signals through a circuit of 40′, but failed for longer distances from the circumstance that he used a quantity current. His friend, Dr. Gale, made for him an intensity battery, and added a hundred or more turns to the coil of wire around the poles of the magnet. With these necessary (and radical) improvements the apparatus was made to work through ten miles of wire. In applying for a caveat for his invention, October 6, 1837, Professor Morse specified six distinct parts, not one of which enters into the established "Morse" telegraph of to-day. Mr. Taylor shows that Professor Morse's real contribution to telegraphy consists first in the adaptation of the armature of a Henry electro-magnet to the purpose of a recording instrument; and second, in connection therewith, the improvement on the Gauss and Steinheil dual-sign alphabets, made by employing the single line dot and dash alphabet.

In his general summary of the history of the origin and development of the electro-magnetic telegraph, Mr. Taylor sets down the leading preparatory investigations and discoveries as these five:

1. The discovery of galvanic electricity by Galvani, 1786–1790.
2. The galvanic or voltaic battery by Volta, 1800.
3. The directive influence of the galvanic current on a magnetic needle by Romagnosi, 1802, and by Oersted, 1820.
4. The galvanometer by Schweigger, 1820 (the parent of the needle system).
5. The electro-magnet by Arago and Sturgeon, 1820–1825 (the parent of the magnet system).

The second half dozen capital steps in the evolution of telegraphy were: —

1. Henry's most vital discovery, in 1829 and 1830, of the intensity magnet and its intimate relation to the intensity battery.

2. Gauss's improvement, in 1833 (or probably Schilling's, considerably earlier), of reducing the electric conductors to a single circuit by the ingenious application of a dual sign, so combined as to produce a true alphabet. (The anticipations of this idea by Lomond in 1787, Cavallo in 1795, and Dyar in 1825, are not regarded as practically influential in the progress of telegraphy.)

3. Weber's discovery, in 1833, that the conducting wires of an electric telegraph could be carried through the air without insulation, except at the points of support.

4. As a valuable adjunct to telegraphy, Daniell's invention of a constant galvanic battery in 1836.

5. Steinheil's discovery, in 1837, that a single conducting wire is sufficient for telegraphic purposes.

6. Morse's adaptation of the armature of a Henry electro-magnet as a recording instrument, 1837, and the single line dot and dash alphabet in 1838.

The earlier needle type of electro-magnetic telegraph has found its special application in ocean lines, no element of the Morse system entering into the operation of submarine cables.

The more recent telegraphic developments do not fall within the scope of Mr. Taylor's review. A few other dates, as given by Prescott, may appropriately serve to complete this chronology.

1861. — Reiss discovered that a vibrating diaphragm could be actuated by the voice so as to cause the pitch and rhythm of vocal sounds to be transmitted to a distance and reproduced by electro-magnetism.

1872. — Stearns perfected a duplex system, whereby two communications could be simultaneously transmitted over one wire.

1874. — Edison's quadruplex system was invented.

1874. — Gray invented a method of electrical transmission, by means of which the intensity of tones as well as their pitch and rhythm could be reproduced at a distance; and subsequently conceived the idea of controlling the formation of electric waves by means of the vibrations of a diaphragm capable of responding to all the tones of the human voice.

1876. — Telephone invented. — Bell invented an improvement in the apparatus for the transmission and reproduction of articulate speech, in which magneto-electric currents were superposed upon a voltaic circuit, and actuated an iron diaphragm attached to a soft iron magnet. During the same year Dolbear conceived the idea of using permanent magnets in place of the electro-magnets and battery previously employed, and of using the same instrument for both sending and receiving.

1877. — Edison's carbon telephone was brought out.

To these may be added Edison's electro-motograph or electro-chemical telephone, 1877.

1878. — Duplexing of ocean telegraph.

1879. — Cowper's writing telegraph.

1880. — Field's successful substitution of dynamo-electricity for galvanic batteries in telegraphing.

1800. — Volta, Italian, discovery of galvanism.
Galvani, Italian, discovery of galvanism.

1809. — Soemmering, suggestion of application of galvanism to telegraph.
Oersted, Dane, galvanometer.
Ampère, French, astatic needle.

1825. — Ohm, German, law of strength of current.

1833. — Gauss.
Weber.
Becquerel, constant battery.
Daniell, constant battery.
Steinheil, discovery of earth circuit.

Commander Cameron of the British navy says that the Morse system of telegraphy, as far as it depends on the length of sounds, has long been in use in Africa. He has found tribes that, by stationing drummers at intervals, carry intelligence for miles with great rapidity, the beats of the drum being made in accordance with a previous arrangement of signals.

A message of 69 words, forwarded by the governor of Victoria, announcing the opening of the Melbourne Exhibition, was dispatched from Melbourne at 1 P. M., and reached London at 3.43 A. M., on the same day, or 9 hours 17 minutes before the hour of its dispatch. Allowing, however, for the difference of time between the two cities, it occupied only 23 minutes in transit. The route of the message was over the lines of the Victorian and South Australian colonies, the cables of the Eastern Extension, Australasia, and China Telegraph Company, the lines of the Indian government, the cables of the Eastern Telegraph Company, and the lines of the Egyptian and French governments, and the rapidity of its transmission shows the harmony with which these various administrations work together. The total distance traversed was 13,398 miles.

The annual report of the president of the Western Union Telegraph Company for the year ending June 30, 1880, furnishes many figures of interest to others than the stockholders of the company. The latter, however, appear to have no reason to complain, the net profits of the company for

the year footing up over $5,000,000, the capital stock of the company being about $41,000,000. The net profits for the fourteen years from 1866 to 1880 exceed $45,000,000. The telegraph business of the year is represented by 29,215,509 messages, $12,782,894.53 receipts, $6,948,956.74 expenses, and $5,833,937.79 profits. The company has in operation 85,645 miles of line, 233,534 miles of wire, and occupies 9,077 offices. The new offices established and equipped during the year number 543. The number of messages sent was over 4,000,000 more than the year before. The increase in mileage of wire was 22,000 miles; the increase in miles of pole lines was 2,658. The ratio of expenses was 54.3 per cent. of the receipts, against expenses of 56.2 per cent. the previous year, and of 68.9 per cent. the year preceding that, and the cost per message reduced to the average of 22.3 cents, against 23.1 cents the previous year, 25 cents the year preceding that, and 29.8 cents the year ending in 1877.

The wires of long circuits in continental Europe are 5 mm. diameter, weighing about 540 lbs. per English mile.

Smaller lines have wire of 4 mm., = to Am. No. 9, about 320 lbs. per mile.

Branch lines have wire of 3 mm., = 200 lbs. per mile.

In England large and important lines use No. 4 gage, = 800 lbs. per mile.

The majority of American lines has No. 9 gage, = 320 lbs. per mile. A portion of the remainder is No. 8, = 330 lbs. per mile. 3 per cent. is No. 6, = 540 lbs.; and some No. 10, = 270 lbs.

The Cumming periphery-contact telegraph key, it is claimed, has no jar or sticking points, and has a close needle point contact. Two disks are placed at right angles to each other, and the connection between the two is only a needle-point of surface. The adjustability of the electrodes is such that if connection should be arrested, both wheels can be changed in an instant by turning each slightly on its axis to a new bright surface. The electrodes connect firmly, so that the trunnion can be screwed tight without affecting the correct working of the key. The system of wheels and axles forms an elastic bed, that, taken in connection with the dot contact and close adjustment, makes it possible to work the key all day without any lost motion to fatigue the hand or try the nerves.

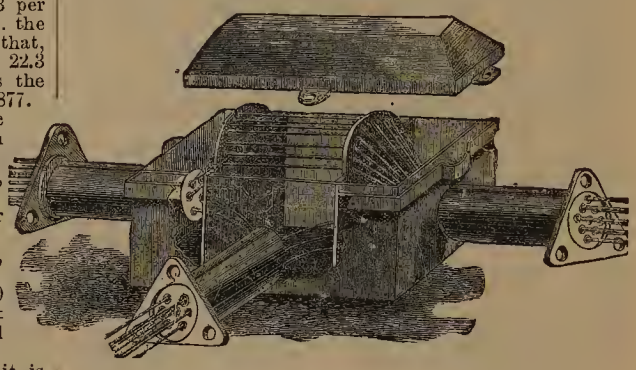
Commander Perrier read a paper at the last meeting of the Geographical Society of Paris, on the determination of the longitude of Algiers by telegraphy. The exact longitude is 2′ 50.21″ east from Paris, the probable error being only 0.01″. The time required for the transmission of the electricity from Paris to Marseilles was found to be only 2-100 of a second; the distance between these two cities being 863 kilometers, it shows that the velocity of the electricity was not less than 46,000 kilometers per second. Similar experiments tried on the submarine cable between Algiers and Marseilles proved that the time required to travel was 23-100 of a second; for a distance of 926 kilometers this shows a velocity of only 4,000 kilometers. But the battery used for signaling in the aërial line was composed of 100 elements, and only ten elements were used in the sub-Mediterranean cable.

For history of and record of improvements, see —

Telegraphy, history of		"*Manufacturer & Builder*," p. 62, 1873; x. 110.
Musical, *La Cour*	*	"*Scientific American*," xxxv. 136.
Progress of.		
C. W. Siemens		"*Scientific American Sup.*," 1813.
Ocean telegraphy, paper on, *Field*		"*Scientific American*," xl. 195.
Longitude by telegraph		"*Scientific American Sup.*," 1366.
Multiplex printing telegraph, *Baudot*, Fr.	*	"*Engineering*," xxvi. 227.
Multiplex telegraph.		
Meyer-Baudot		"*Telegraphic Journal*," vi. 502.
Meyer	*	"*Engineering*," xxiv. 6.
Telegraphing without wires		"*Scientific Amer.*," xxxviii. 97.
		"*Scientific American Sup.*," 908.
Telegraph, underground		"*Scientific Amer.*," xxxvi. 311.
System, *Meyers*	*	*Lines*' "*Rept. Vienna Exp.*," 1873.
Writing, *Dolbear*	*	"*Scientific American*," xl. 376.
New Zealand		"*Scientific American Sup.*," 3.
Apparatus, ocean		"*Scientific American Sup.*," 145.
Pneumatic, *Guattari*	*	"*Scientific American Sup.*," 555.
Cable, appr., *Tomassi*	*	"*Telegraphic Journal*," vi. 47.
Cables, Atlantic, "*Engineering*"		"*Van Nostr. Mag.*," xxiii. 502.
Relative durability		"*Telegraphic Journal*," iv. 56.
Cable ship "Faraday"	*	"*Engineer*," xli. 295.
Electro-harmonic, *Gray*		"*Scientific American*," xxxv. 258.
Key, *Byrns*	*	"*Scientific American Sup.*," 807.
Double current, *Trimmer*	*	"*Scientific American Sup.*," 1478.
Instrument, *Bramäo*	*	"*Telegraphic Journal*," vii. 114.
Sound	*	"*Scientific American*," xxxv. 391
Military, *Trouve*	*	"*Scientific American*," xxxv. 23.

Tel'e-graph Wire. In one form of underground telegraph system the naked copper wires are drawn through glass tubes, which are firmly held in position in the iron pipe by paraffine wax. For lateral connections, as well as convenience in laying, traps are used, into which the pipes are screwed, the wires passing over non-conducting bridges, as

Fig. 2398.



Trap for Underground Telegraph Wire.

shown in Fig. 2398, thus allowing any wire to be taken out and replaced without interfering with the working of the others. The pipes are connected by a coupling, which, after being bolted together, is completely sealed; the traps being closed and sealed in like manner.

By this system there is claimed to be no crossing of wires, no difficulty from atmospheric changes, no cutting of wires in cases of riot, no imperiling of life and property by the breaking down of poles and wires by snow storms or fires (causing interruption of telegraphic communication); but a perfectly reliable telegraphic connection under all circumstances.

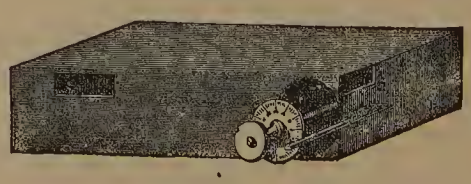
Te-lem'a-chon. A name applied by Wallace, of Ansonia, Conn., to his apparatus for transferring power from the Naugatuck river to his factory, a quarter of a mile off. A dynamo-electric machine transforms mechanical power into electricity, and an electric motor reverses the operation and turns the current into power. Loss stated at 20 per cent.

Te-lem'e-ter. A device for determining rapidly and accurately distances on the earth's surface.

Various mechanical devices for these purposes have been invented, but none hitherto similar to that illustrated, devised by Lieutenant Gaumet, French army, which is adapted for carriage in the pocket. A perspective view of the instrument is given in Fig. 2399. Fig. 2400 shows the interior. Two mirrors are disposed on a metallic plate so that an angle of 45° is made between them. One mirror is fixed; the other is mounted on a movable alidade, so that the above angle can be varied from 41° to 49°. A micrometric screw of .04″ travel per turn has a disk on its head, which is divided circumferentially into 100 parts. This screw moves in double nuts on the metallic plate. The disk travels in front of a divided rule, each division of which equals .04″. A spring causes constant contact between the arm of the alidade and the extremity of the micrometric screw.

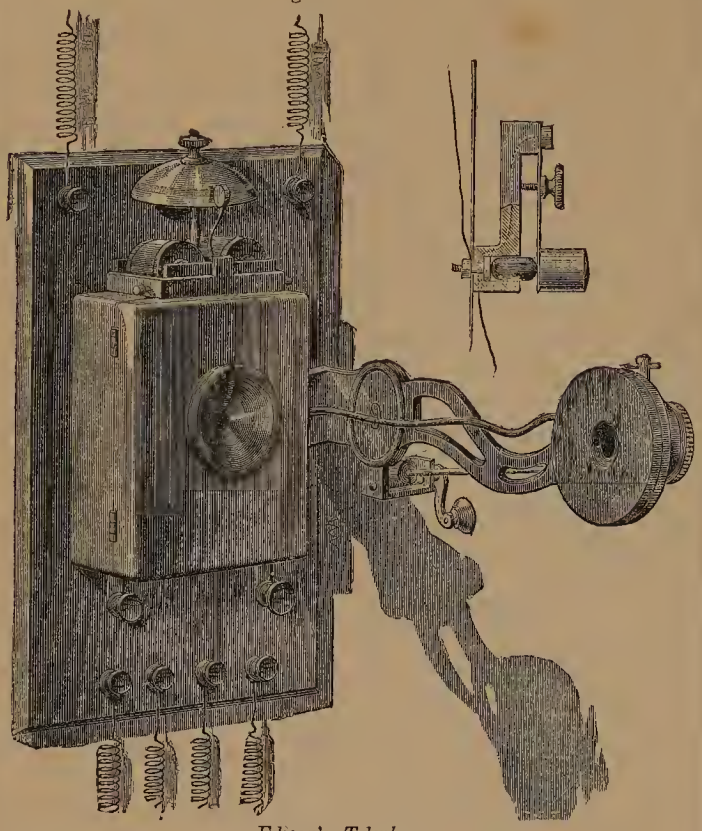
All the above parts are contained in a rectangular box, as shown in Fig. 2399, having at its rear an opening for the eye, and on the right side a similar aperture through which the

Fig. 2399.



Telemeter.

Fig. 2403.

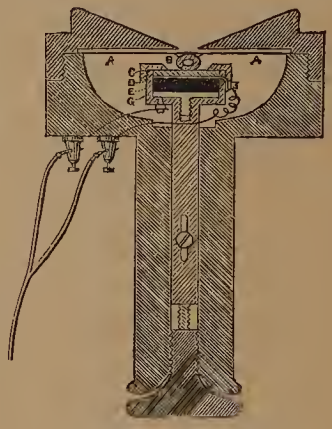


Edison's Telephone.

Fig. 2402.

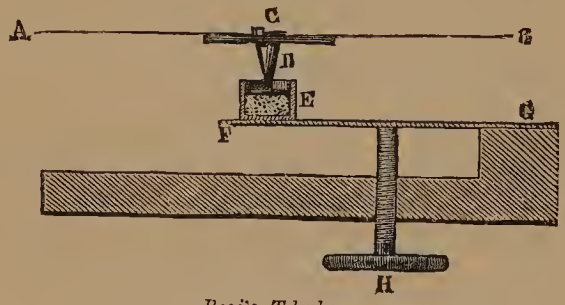
Bell's Telephone.

Fig. 2404.



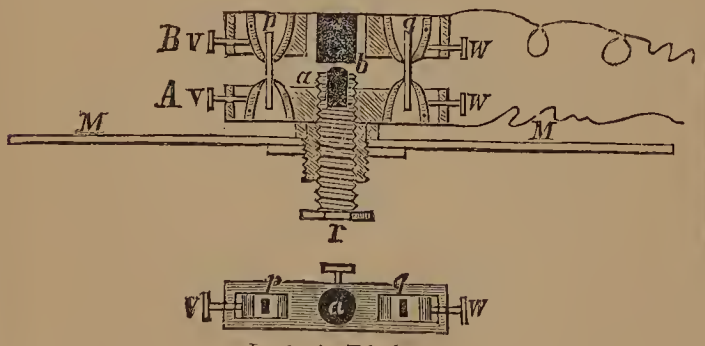
Edison's Carbon Telephone.

Fig. 2405.



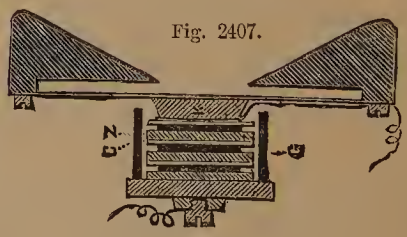
Regi's Telephone.

Fig. 2406.



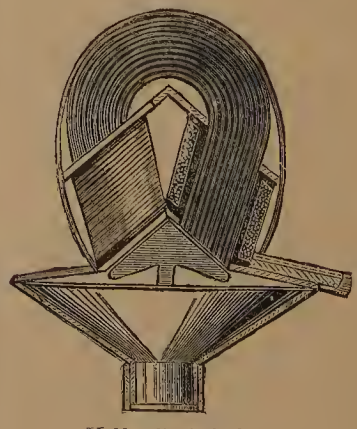
Luedtge's Telephone.

Fig. 2407.



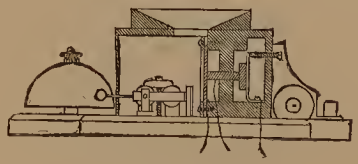
Edison's Pile Telephone.

Fig. 2408.



Hubbard's Telephone.

Fig. 2409.



Herz's Telephone.

rays pass to the mirrors. The principle on which the device is constructed is a simple application of that of double reflection. When a luminous ray is reflected successively by two mirrors placed in a plane perpendicular to the intersection of the mirrors, the angle formed by the incident and reflected ray is double the angle of the mirrors.

In order to measure the distance by the instrument three operations are necessary. These will be understood from Fig. 2401, and are as follows: 1, to determine the right angle *C A M;* 2, measure a base *A B;* 3, measure an angle at *A C B*, *A C* being the distance to be determined. The observer posts himself at *A*, the point *C* being on his right. The reflected image of this point then appears directly above the direct image of the fixed station *M*, which is regarded in direction perpendicular to *A C*. (The angle *C A M* is right whenever the two mirrors make an angle of 45°.) The observer now, by means of a tape provided with the instrument, measures off a distance along the line *A M* of *A B* = 60′. He then proceeds to *B* and regards anew the signal point *M*, between which and *C* there will no longer be a coincidence, the latter appearing to the right, say at *C″*. To reëstablish the coincidence the movable mirror is turned to an angle equal to ½ *C″ B M*, which equals ½ *A C B*. The angle of rotation of the mirror is in the instrument measured by its tangent by the aid of the micrometric screw. This gives a very close approximation. When the coincidence above referred to is obtained the number of turns made by the screw is read from the scale, and this equals the measure of the tangent of the angle of rotation of the mirror. This angle of rotation is half the angle *A C B*. The relation, therefore, between the distance from the pivot of the movable mirror to the axis of the micrometric screw and double the number of divisions equals the ratio between the unknown distance and the base measure. Therefore, *D* being the distance to measure; *b*, the base taken, say 60′; *l*, the distance of the pivot as above, which in the instrument is 2.2″, and *n* the number of divisions, we have

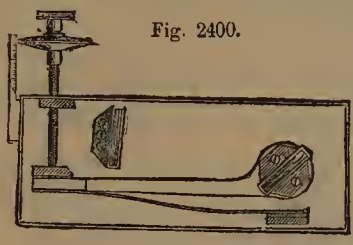


Fig. 2400.

Telemeter.

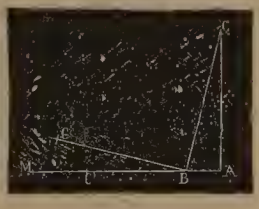


Fig. 2401.

Plan reflected in the Telemeter.

$$\frac{D}{b} = \frac{1}{2.n}. \quad \text{or } D = b\,\frac{2.2}{n}.$$

Whence we obtain for each instrument a constant which, divided by the number on the scale, at once gives the distance sought. On every instrument a tablo prepared from the above formula is fixed so that the observer merely has to glauce thereat to determine the distance without caleulation.

This invention is in principle the same as that patented in the United States, March 16, 1875, by Mr. William F. Hausch, of Chicago, Ill.

Tel'e-phone. An acoustic telegraph.

A modification of the electric telegraph, whereby sounds, and especially articulate sounds are conveyed to a distance.

The telephone of Prof. Alex. Graham Bell, Plate XLVII., Fig. 2402, consists of an insulated permanent magnet, in form of a cylindrical rod, which is enveloped with a wire coil that communicates at one extremity with the grouud and by its other extremity with a similar coil around a like magnet at the distant station whose unattached end communicates in like manuer with the grouud. Opposite the outer end of each magnet is stretched a thin metallic diaphragm (usually ferroty pe sheets) to which a mouth-piece is attached. Sounds projected into the mouthpiece vibrate the diaphragm, and by so doing increase and diminish the polarity of the magnet. This acting inductively on the inclosing coil transmits electrical impulses througb the conneeting wire to the distant coil, which in turn operates to magnetize and demagnetize its inclosed bar, which finally sets up vibrations on the adjacent diapbragm, similar to tbat in the sending station, thus converting the electrical impulses back into sound.

Tbe *telephone system* depends for its efficiency upon three distinct elements: the telephone, the microphone transmitter, and the exchange table and system.

The telephone generally used consists essentially of a thin metallic diaphragm, suitably mounted in a sound-receiving chamber with a mouth-piece, and a short bar of magnetized iron secured adjustably in the handle of the instrument at right angles to tbe diaphragm, nearly, but not quite in contact tberewith. A coil of insulated wire surrounds tbe magnetized bar at its diaphragm end, and is connected with the line wire and with the ground respectively.

Speech or other sounds projected into the mouth-piece cause vibratious of the diaphragm which produce fluctuatious in the magnetism of the bar. Indneed currents of electricity are thereby brought iuto play in tbe coil surrounding tbe magnet, which, being trausmitted by the line wire to tbe termiuus, cause precisely similar vibrations in the diaphragm of the receiving instrument, and thus, by an exact reverse of the previous process, produce souud waves.

Thus by the conversion, so to speak, of sound waves into electrical waves, the transmission of the latter, and finally their recouversion into sound waves, the sounds given to the receiving instrument are reproduced at remote distances with astonishing accuracy; but the favorable results produced are much enhanced by the use of a microphone known as the *transmitter*, which is now used as the seuding instrument.

The transmitter is a modification of the principle of the telepbone proper, in which a diaphragm mounted in an insulating rubber marginal support vibrates against a spring-supported platinum point interposed between the diaphragm and a disk of compressed carbon. The platinum point and the carbon disk are electrically connected through an insulated coil, surrounded by a secondary coil interposed between the linc wire and the ground connection. The object of this invention is to produce secondary pulsations of greater intensity, which, being transmitted by the line wire, practically solve the question of distance in the transmission of sound.

Telephone exchange. Each subscriber to a local telephone system is connected by a line wire to a central office or *exchange*, where, for convenience, the subscribers are grouped to the number, say of fifty, the wires of each group concentrating at a particular desk in charge of an operator clerk, and distinguished by a particular color. At the exchange terminus of each wire is a magnet mounted on a frame, which, when the line is out of use, holds a bright colored disk in sight. These magnets being arranged on shelves in front of the operator, each will drop its disk whenever its patron "calls" the exchange, tbus indicating the individual giviug the signal.

Each desk has a similar group of magnets and signals connected with the wires belonging to its group of patrons, and, in addition, a number of *plug-sockets* with wires connecting tbem with the other tables. These plug-sockets are arranged in groups of ten, and each group has its distinguishing color, and is conuected with the groups of the same color on each of the other tables; thus each table has as many groups of sockets and connecting wires as there are tables in the exchange. By this means each operator may connect either of the wires distinguished by his appointed color with any other table, and, thus intermediately with any other line wire to such other patron as the original ealler may indicate telephonically to the central exchange.

Fig. 2403, Plate XLVII., represents Edison's new telephone. The chalk cylinder is inclosed in a vulcanite box at the end of the movable arm. The cylinder, when once moistened, remains in that condition an indefinite time, as the box is practically air-tight. The small shaft that runs parallel with the iron arm extends througb the side of the box and carries the cbalk cylinder. Upon the opposite end there is a small pinion moved by a worm, the crank of which is turned by the finger. The diaphragm of the receiving instrument is covered by the front of the box, except a small central portion suffieient for the exit of tbe sound. The arm that supports the receiving instrument is jointed so that it can be raised vertically out of the way when the telephone is not in use. The transmitter is contained in the rectangular box; its mouth-piece projecting slightly, and the diaphragm, which is of mica, is supported by a metallic frame and springs inside the box cover. The transmitter is so constructed that a vulcanite arm is secured to the center of the mica diaphragm by a small bolt that is connected to one pole of the battery by a piece of metallic foil or very thin copper wire. The head of the bolt is platinum faced and deeply sunk in the vulcanite arm, the same cavity containing also a piece of carbon pencil, such as is used for electric candles. This carbon fits the cavity loosely, and is rounded at both ends. Its outer end is pressed by a platinum-faced spring, secured to the outer end of the vulcanite arm. The spring carries at its free end, opposite the carbon, a brass weigbt, and its pressure upon the latter is regulated by the small set screw. A wire or piece of copper foil, connecting with the spring, completes the circuit, which includes the primary of an induction coil contained by the rectangular box. The secondary wire of the induction coil is connected with the telephonic line and a tertiary coil that envelopes the secondary is connected with the rubber and chalk cylinder.

Fig. 2404, Plate XLVII., represents the "Edison" carbon telephone. He made the discovery that when properly prepared, carbon possesses the remarkable property of changing its resistance with pressure, and that the ratios of these changes correspond exactly with the pressure. On this principle he constructed his telephone. The carbon disk is represented near the diaphragm, which is placed between platinum plates and connected with the battery circuit. A small piece of rubber tubing is attached to the center of the metallic diaphragm, and presses lightly against an ivory piece that is placed directly over one of the platinum plates. When, therefore, any motion is given to the diaphragm, it is immediately followed by a correspouding pressure on the carbon, and by a change of resistance in the latter.

The "Regi" instrument, Fig. 2405, Plate XLVII., has the special advantage that when once adjusted it continues to operate without readjustment. The peculiarity of the new instrument is in transmitting wave-sounds through a diaphragm that rests upon a conducting substance made of a mixture of silver, reduced to an impalpable powder, and carbon, also very finely pulverized; the above devices being mounted on the end of a slender spriug.

In principle the Regi telephone is similar to "Edison's" carbon telephone, and also to the "Hughes," which was based on Edisou's.

Professor Gray received a patent for a combination of a telephone with the ordinary Morse instrument, so that the telegrapher may communicate over the same line both by the Morse signals and also by the voice. By use of the quadruplex iustrument on such a line four messages may be transmitted by siguals in the usual manner, while conversation may at the same time be carried on over the same wire, all without any iuterference of the different signals or systems.

Gray claims to have first invented and reduced to practice —

1. The transmission of composite tones of varyiug quality through a closed circuit by the superposition of one set of electric waves upon another.

2. The reproduction of such vibrations by means of a coutinuously charged receiving magnet.

3. The combination of a maguet with a diaphragm of magnetic metal arranged in close proximity thereto, and adapted to act either as a transmitter or receiver of articulate or auy other sound.

"Dr. Luedtge's microphone," Fig. 2406, Plate XLVII., patented January 12, 1878, some time before the microphone notes of Hughes and Edison were published, has been improved so that the disagreeable sounds that are heard on some other microphones have been avoided, and words spoken into the transmitter are reproduced so clearly and so loud that it can be heard best somewhat removed from the receiver, which is an ordinary "Bell" telephone. With too near an approach a healthy ear might be injured.

Words have been plainly transmitted by this apparatus through a distance of 186 miles.

If a Bell telephone and a Luedtge microphone are brought in connection, a clear, deep, and impressive tone, something like the tone of a fog-horn that can be heard for quite a distaunce, is perceived at the transmitting as well as at the receiving station.

The essential part of the instrument is the connection between the two electric conducting bodies (preferably of irou, platinum, or carbon). One of the pieces is level at the contact surface, but the other is couvex. The elcctric current passes through this contact, and the variations in the electrical resistance at this point while speaking cause the vibrations of the membrane in the receiving telephone. A peculiarity of the construction is that both of the contact pieces are united to a support fasteued to the middle of the membraue, so that both vibrate with the membranc.

Fig. 2407, Plate XLVII., represents Edison's voltaic pile telephone. A piece of cork, *K*, is fastcued to the diaphragm, and presses upon a strip of platinum which is attached to a plate of copper. The latter is onc of the terminals of an ordinary galvanic pile. The other terminal platc presses against the metallic frame of the instrument. When the pile is included in a closed telephone circuit it furnishes a continuous current. The strength of this current depends upon the internal resistance of the pile and its polarization, and these are varied by vibrating the diaphragm. The pile is composed of alternate plates of zinc and copper, *Z C*, and a bibulous medium, *G*, between the pairs of plates.

In the Hubbard telephone, as seen in Fig. 2408, Plate XLVII., the inventor has made use of the Jamin laminated U-magnets to secure great magnetic power with little weight. The ends of the magnet are cut off diagonally, and the poles are each surrounded with a helix of fine insulated copper wire counected as in an electro-magnet. Two of these magnets are attached to an elliptical hoop, which surrounds the head and supports the diaphragms and ear-pieces. Each diaphragm carries a light triangular armature, which fits the poles of the magnets and uearly touches them. The telephoues are connected with each other and with the line. The operation is similar to the Bell telephone. The iustrument shown in the engraving is arranged as a receiver to be used with any of the ordinary transmitters, but it may be arranged as a transmitter.

Fig. 2409, Plate XLVII., represents the telephonic instruments of Dr. Cornelius Herz.

The apparatus represented in the figure is specially designed for lines most affected by induction, which renders communication impossible with ordinary telephones.

This plan utilizes two priuciples discovered by Dr. Herz: the alternation of the current in the liue, and employing condensers as receivers. The instrument constitutes a station, completely inclosing, under a compact aud appropriate form, all the parts necessary for the call and for communication.

The diaphragm is horizontal, but a funnel placed in front of the box collects the sound and concentrates it upon the diaphragm, and the instrument will transmit words spoken fifty centimeters from it.

Four pairs of microphonic contacts are placed upon an oscillating platform, under the diaphragm and connected with it by a rigid rod, communicating to it all the vibrations of the diaphragm. These contacts are of a special composition, and commuuicate with the battery and with the line.

In this apparatus it is uot necessary to use the induction coil, but it is necessary that the number of elements of the battery in the line be proportioned to the distance of the two stations; for example, between Paris and Orleans it was necessary to use thirty elements of Daniell at each station, in order to obtain the maximum intensity.

In a modification the alternation of the current is accomplished in a different manner, and the induction coil is used in order to diminish the number of elements necessary in a long line.

Originally this instrument was formed of a vibrating plate, having at each side a coutact point touching the diaphragm lightly, and the vibrations increased or diminished the pressure alternately upon each one of these contacts, but this form being inconvenient, M. Herz preferred that which is now used, which gives the same results.

The vibrating plate is of conducting material. Below, and touching it lightly, is a cylinder, which rests upon a disk, the two being made of the same material as the plate. The disk rests, in its turn, upon a thin metal spring, which is made adjustable by meaus of a screw, so as to vary the contact between tbe three pieces.

The plate and the disk are connected with one of the poles of a battery of four elements, which is grounded at the center. Finally, the cylinder is connected with one of the extremities of the primary wire of the induction coil, the other end being grounded. The secondary wire of the coil passes out from one side to the line, and from the other side to the ground.

An electro-thermic telephone, described by W. H. Preece in a paper before the Royal Society, consists of a telephone receiver whose action is due to the linear expansion of a thin wire under tension when placed iu a microphonic circuit.

It has been discovered that each damaged or imperfect joint in a telephonic wire becomes a microphone, taking up the sounds that occur in its vicinity for transmission to the receiver.

The microphone, in fact, is itself two or more conductors, connected together, electrically, by an imperfect joint.

Mr. Geo. Hopkins, of Brooklyu, N. Y., during a thunder storm, connected the gas and water-pipes of his dwelling with an ordinary Bell telephone, and discovered that the electric discharges were plainly indicated by either a sharp crack or by a succession of taps. This occurred when the discharge was so distant that the thunder was inaudible. There was a marked difference in the discharges; some that appeared single to the eye were really multiple. Often the discharges would consist of a series, beginning and ending with discharges larger than the rest, thus: —— . . . . . ——, sometimes it would be thus: —— . . . . ., sometimes the reverse, and often a single crack.

Experiments with the telephone as an indicator of the approach of distant thunder storms seem to prove that the telephonic dispatch was simultaneous with the rays of light, as exhibited by the flash of the lightniug, even when the storm was so distant that the sound waves were not appreciable to the car via the atmosphere. A significant fact, if sound waves with a conductor with a minimum friction can keep pace with rays of light.

The nearest cable station from Alexandria during its bombardment, in 1882, was at Malta, distant about 1,000 miles from the scene of the battle. A press dispatch says that when a telephone was attached to the Malta end of the cable the firing of the guns at Alexandria could be distinctly heard, though no oral communication was possible over that length of cable.

See "*Mech. Dict.*," 2514.

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* "*Jour. Soc. Tel. Eng.*," v. 500, 519, 525; vi. 385.
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* "*Scientific American*," xxxvi. 191; xxxvii. 207.
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* "*Telegraphic Journal*," vi. 158.
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* "*Telegraphic Journal*," vii. 75.
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* "*Scientific American Sup.*," 2040.
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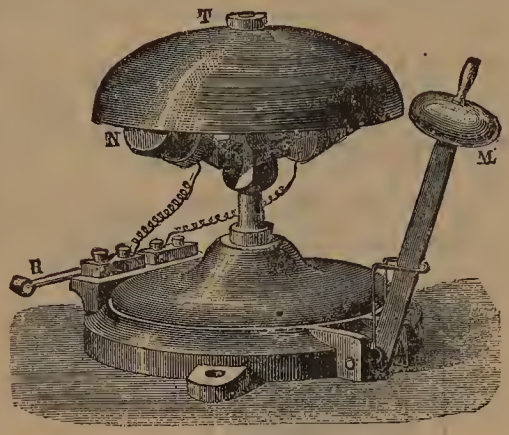
Fig. 2410.



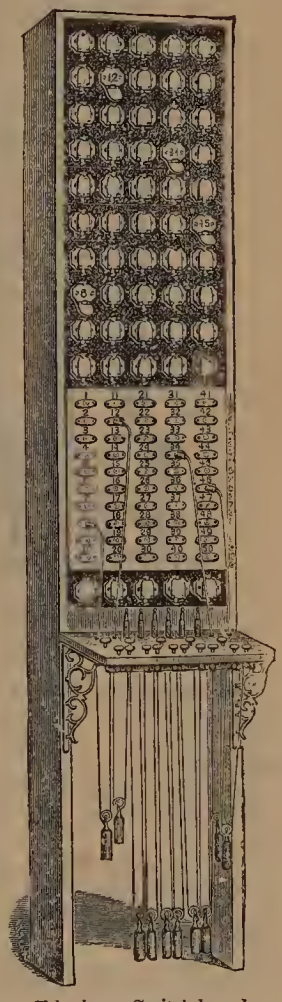
Telephone Call.

Tel'e-phone Call.

The Lorenz telephone call, Fig. 2410, is an alarm or call-bell, in which the magnet *N S* is placed coincident with a diameter of the steel gong *T*. When by means of a hammer *M*, pushed by a spring, the gong is struck in a direction across that of the magnet the vibrations have their maximum amplitude in front of the poles, and induction currents relatively strong are generated in the coils placed on the poles of the magnet. These currents are sent to the corresponding station, and are there received in the Bell telephone, slightly modified, the bobbins being more powerful than in ordinary telephones, and a resonator being also added to them. The latter is a long cone of white iron, truncated at its top, the small end being inserted close to the telephone diaphragm.

"*Telegraphic Journal*," * vi. 439.

Fig. 2411.



Telephone Switch-board.

Tel'e-phone Ex'change Ap'pa-ra'tus. Fig. 2410 is the Western Telephone Exchange switch board. It consists of fifty annunciators for subscribers' wires; fifty spring-jack switches for connecting and disconnecting line wires and annunciators; five annunciators for receiving the clearing-out signals. A shelf with five pairs of cords and plugs, and five sets of keys.

Tel'e-phone Harp. An instrument for making telephonic musical effects more audible for large audiences.

Gower, Br. . . "*Jour. Soc. Teleg. Engineers*," vii. 259.

Tel'e-phon'o-graph. An invention of Edison, a combination of the telephone and phonograph, for

making a phonic record of a message conveyed from a distance.

"*Engineer*" . . . . . * xlvi. 425, Fig. 27.

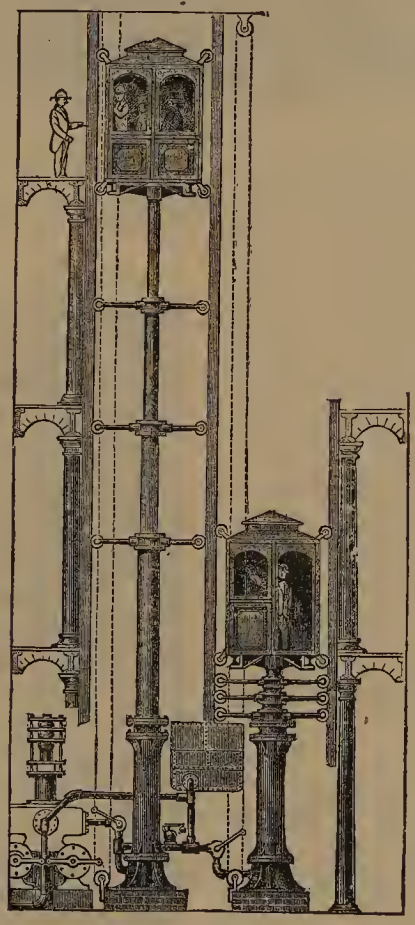
Tel'e-phote. An instrument or apparatus for conveying messages or images by transmission of light.

This broad definition may include the heliotrope, but nothing narrower, it appears, will include the various ideas and inventions of Bell, Perry, Ayrton, Edison, Adams, Day, Willoughby, Smith, Sabine, Kerr, Middleton, Michin, and others, who are reported to be working at the problem.

See sketch in "*Engineering*," xxix. 361.

Tel'e-scop'ic El'e-va-tor. Fig. 2412 shows a telescopic hydraulic elevator for lifting passengers or freight to the upper floors of a building.

Fig. 2412.



Telescopic Elevator.

Tel'e-scop'ic Tank Car. One in which the circular sections of the tank are of gradually decreasing diameter toward the ends, lapped within each other.

In contradistinction to the *straight tank* car, in which the sections are alternately inside and outside.

Tel'e-scope Sight. (*Fire-arms.*) A telescope mounted on a fire-arm. It is generally adjustable, in altitude for distance; in azimuth for wind correction.

See patents of J. M. Trowbridge, March 8, 1864, No. 41,874; C. Slotserbek, October 8, 1878, No. 208,765.

Tell'-tale. (*Gas.*) An attachment to a station meter to indicate any irregularity of the production of gas during the 24 hours, the cards being renewed daily.

Tell'-tale Com'pass. A tell-tale mariner's compass, recently patented in England by Mr. H. A. Severn, is intended to serve captains of vessels as a check upon the man at the wheel during their absence, and to insure greater attention on the part of the helmsman.

It consists of an ordinary compass card, to the center of whose upper surface is attached a metallic bar, through the agency of which an electric circuit is closed, and a bell is sounded as soon as the vessel is off her course either way beyond a given amount of latitude. To effect this there are two index hands, which may be set at will at any distance on either side of the metal bar. These hands carry at their ends thick platinum wires, bent downward, so that they are touched by the metallic bar on the compass card as soon as the vessel is out of her course beyond the given limit. These wires are connected to one pole of a Leclanché battery, while the point carrying the card is connected with the other. The compass can also be used in the ordinary manner.

Tem'pered Glass. (*Glass.*) A process invented by M. de la Bastie, which consists in heating a piece or object of glass to such a heat as to approach malleability, but not hot enough to lose its shape, and then plunging it into a bath of fatty and resinous matter, which is heated to liquidity and maintained at a heat of from 300° to 600° F., according to the quality of the glass.

The difference of temperature between the malleable state of glass, say 1400° F., and that of the bath constitutes the "temper."

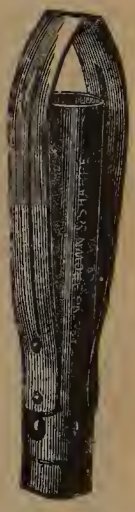
The glass is much strengthened against injury by a blow, but becomes fractured by being cut with a diamond. It resists great changes of temperature. It is much more elastic also.

It can be depolished and cut by the wheel. See also COMPRESSED GLASS.

Tempered Glass, *Baurée* "*Technologiste*," xxxvii. 182-194.
On, *Leger* . . . . "*Technologiste*," xl. 68.

Tem'per-ing. Chisels for dressing French burr stones may be tempered by heating to a dark cherry red, and quenching in the following solution: To three gallons of water add three ounces each of spirit of niter, spirit of hartshorn, white vitriol, sal ammoniac, and alum, and six ounces of common salt, with a double handful of hoof parings.

Fig. 2413.



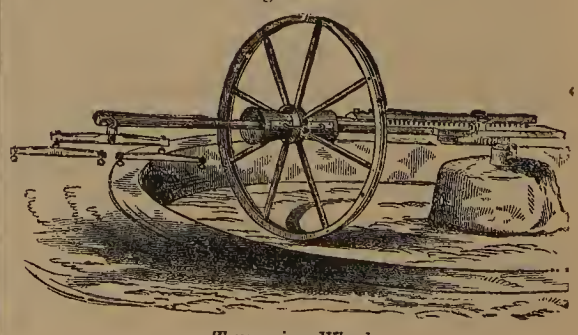
Tempering Gas Heater.

Tem'per-ing Gas Heat'er. A gas heater, Fig. 2413, with directing and concentrating flanges for directing the heat.

Tem'per-ing Wheel. Fig. 2414 represents Allen's clay tempering wheel. It is used in the preparation of clay for making bricks, and for mixing mortar in large quantities; the substance to be worked being placed in a circular pit, as shown in the engraving, of 16′ to 30′ diameter.

It is made with wrought iron or with cast iron arms or spokes, and of any length of shaft required.

Fig. 2414.



Tempering Wheel.

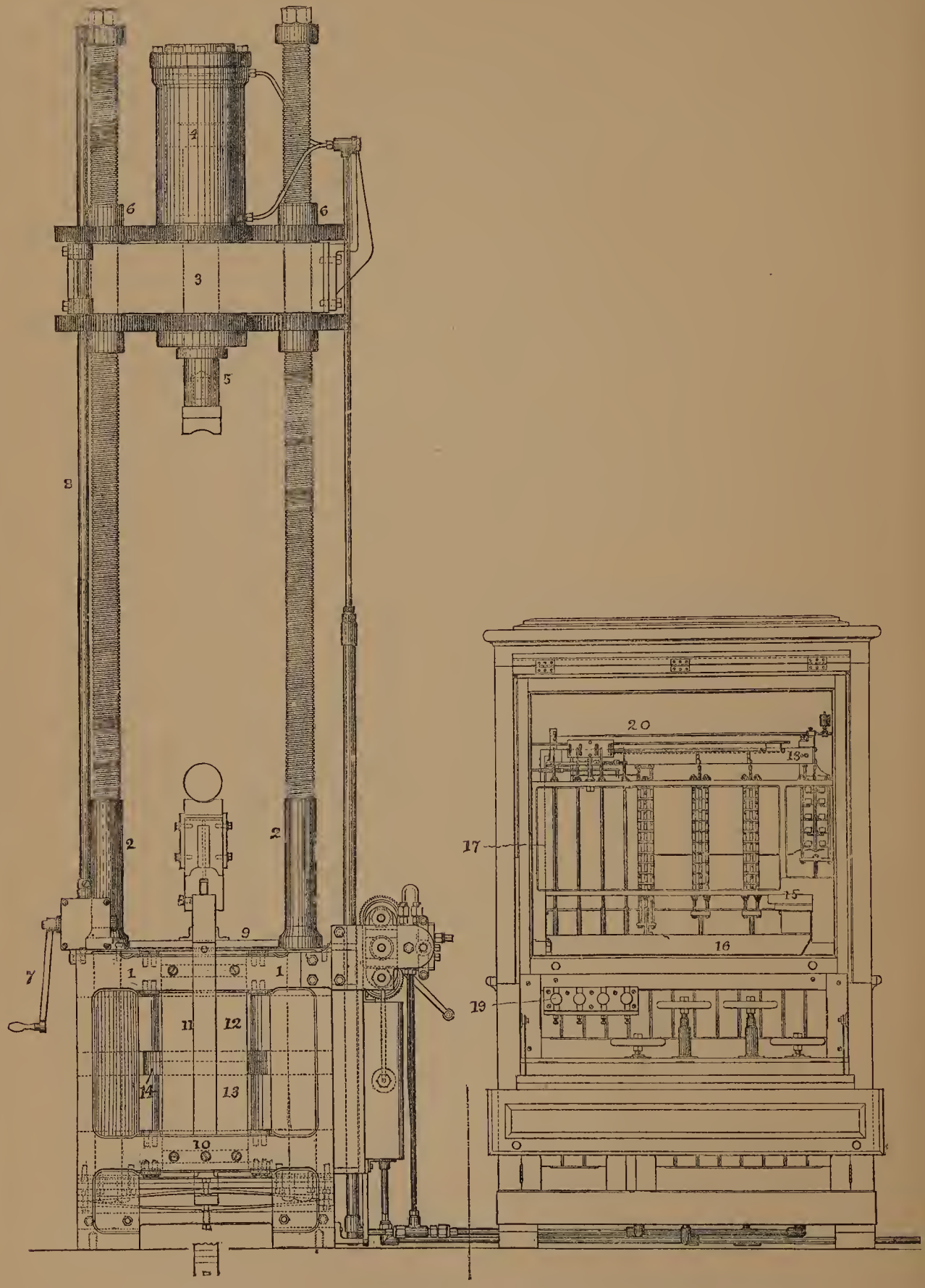


PLATE XLIX. EMERY'S TESTING MACHINE See page 887.

The heaviest piece weighs 830 lbs. The cubic measurement of the whole is about 40′.

Ten-ac′u-lum For′ceps. (*Surgical.*) An instrument for withdrawing and detaining the parietes of an artery to facilitate tying.

Ten-ac′u-lum Nee′dle. (*Surgical.*) A curved surgical needle, Fig. 2415, the invention of Dr. C. J. Cleborne.

Fig. 2415.

Tenaculum Needle.

Ten′der Por′ce-lain. (*Ceramics.*) A soft body porcelain made in Europe.

a. The kaoliu body porcelaiu of Englaud is composed of—

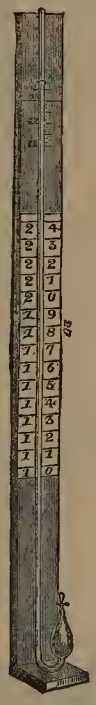
Calcined bone-dust	47
Kaoliu	34
Feldspar	19
	100

The phosphate of lime gives a translucent character, but thc ware is tender and baked at a low heat.

b. Pâte tendre is a vitreous porcelain, formerly made at Sèvres, before the Böttger recipe for hard porcelain was introduced at Sèvres iu 1765. *Vieux Sèvres* was abandoued in 1804.

Ten′sion Ap′pa-ra′tus. Fig. 2416 represents Dalton's apparatus, used by him, for the determination of the tension of the vapor of ether, and is interesting as being the instrument by which he arrived at one of his most important experimental laws, — the law of tensions. Almost all the apparatus of Dalton is of a somewhat rude description; this gives it the more interest, knowing as we do the immense results he obtained with their aid. The one under notice is no exception to this, being made by him of wood, the central figures and lines being written on paper, which is pasted on. It is about 3′ long.

Fig. 2416.



Tension Apparatus.

Ten′sion Rol′ler. A pulley, drum, or roller resting against a belt to cause it to adhere to the driving pulley. A *tightening pulley*.

Fig. 2417.

Dark Tent.

Tent. Fig. 2417 shows a dark tent for use in developing the plates in outdoor photography. The box carrying the tent and forming part of same contains a reservoir and developing tray, and is mounted on a light tripod. One of the many improvements in out-door photography by the Scovill Manufacturing Co., of New York.

Test′ing Ma-chine′. A machine for ascertaining the strength of an object for trial.

A familiar class of machines of this character are *dynamometers*, which are, however, principally adapted to ascertain the power or strength exerted; while those usually termed *testing machines* are intended to ascertain the strength of materials.

There is no absolutely clear line to be drawn between these classes of machines. It is a question of adaptation and application.

The ordinary form of testing machine for ascertaining the strength of metals is founded upon the Roman *statera*, the lever balance, with special arrangements incident to its new function. Such are shown ou pp. 2536–2539, "*Mech. Dict.*":

Ordance Department machine, Fig. 6323.
Prof. Thurston's machine, Fig. 6324.
Colt's armory machiue, Fig. 6325.
Fairbanks's machiue, Figs. 6326, 6327.
Kirkaldy's (English) machine, Fig. 6328.

A number of machines, usually of a smaller size than these which deal with steel rods of inch square section, for instance, are made for various other tests, and these may be found in this volume under the following heads: —

Belt-tension apparatus.	Oil tester.
Cable testing machine.	Paper tester.
Cement tester.	Petroleum tester.
Cloth tester.	Pipe testing machine.
Coal testing apparatus.	Spring tester.
Dynagraph.	Strain measurer.
Dynamometer.	Tannin tester.
Fiber tester.	Taseometer.
Gas testing apparatus.	Test gage.
Lubricant tester.	Wire tester.
Milk testing tube.	Yarn tester.

It should be added that a large number of instruments are also *testers*. As, for instance —

The *photometer* is the tester of the illuminating quality of gas, candles, etc.

The *pulsometer* or *sphygmometer*, of the rate and force of the pulse.

Without adding other instances, please refer to specific index, uuder the caption Measuring, Calculating, Testing, and Recording Instruments.

In the Emery system of testiug machines, scales, gages, and dyuamometers, power is transmitted from the load to the indicating device, by means of liquid acting on diaphragms, so as to avoid friction and give the result with the utmost accuracy.

Plate XLIX. represents a fifty-ton testiug machine made under this system. It is constructed with a bed, 1, to which are firmly fixed stationary straining screws 2. Adjustably mounted on these is a straining beam, 3, carrying a straining press, 4, in which is a double actiug piston, with piston-rod, 5. Geared nuts, 6, operated by a crank, 7, through the medium of a splined shaft, 8, move the straining beam 3 up or dowu to adjust its position for long or short specimens and to give light strains if desired. Heavy strains, and usually light ones, of either tension, or compression or transverse loads are given to the specimen by the hydraulic press piston, 5. The strain is transmitted directly from the specimen to a yoke consisting of a platform, 9, a beam, 10, and counectiug plates, 11, which yoke is fixed in position by flexible plates and transmits pressure in the axis of the machine to a pair of coupled load beams, 12 and 13, between which rests a hydraulic support, 14. With strains of tension, 13 is the free platform and 12 the bed of the scale. For compression or transverse loads, 13 is the bed of the scale and 12 the free platform, the strain being transmitted from the specimen to the support 14 in either direction according to the direction of the strain. The pressure on the liquid in the hydraulic support 14 is conveyed to a small chamber, 15, in the weigh case. From this small chamber the pressure is comunnicated through a fixed fulcrum plate to the levers 16, 15, and from it through a yoke, 17, to a lever, 18, to which are attached a series of poise-rods, each carrying 10 weights which are operated by levers 19, 18. The weights have values of 10, 100, 1,000, aud 10,000 each, depending on which poise-rod they are applied to. An indicator, 20, 19, shows when the scale is balanced. The ratio of movement of the indicator to the platform is 400,000 to 1 in this machine, so that a millionth of an inch movement of the platform gives .40 of au inch at the indicator. The drawing shows the transverse apparatus in position with a specimen ready to be loaded.

A testing machine of four hundred tons capacity built by Mr. Emery for the United States government has been in practical use for seven years without repairs of any sort and its efficiency and delicacy are as great as when first erected.

In regard to this machine the late eminent engineer, Alexander L. Holley, said: —

"The excellence of the machine in every respect is more than satisfactory, and its accuracy is at first sight astonishing, although an investigation of its principles must show that if the weighing apparatus will weigh at all, it must do

so with perfect accuracy, because all its movements are absolutely without friction.

The proof experiments were numerous, and the effects of recoil after sudden ruptures at maximum loads, were watched with great care, but without much anxiety, because the weighing parts affected are by no means delicate in structure and their motion is almost infinitely small. Among the tests were the following: —

"A forged link of hard wrought iron, 5″ in diameter between the eyes, was slowly strained in tension, and broke off with a loud report at 722,800 pounds. The diameter before breaking at the point of fracture was 5.04″; after breaking 4.98″.

"In order to see if the weighing parts had been disturbed by the recoil, which was obviously near the greatest recoil the machine will ever suffer, a horse-hair was next tested; it was 7-1000ths of an inch in diameter; it stretched 30 per cent. and broke at 1 pound. Other horse-hairs varied in tenacity between 1 and 2 pounds. A 5″ round bar, turned down to 3⅜″ in diameter along the center, was pulled apart at 430,200 pounds tension. Then some more horse-hairs were tested; also copper wires 19½-1000ths of an inch in diameter, which averaged 25 pounds tenacity.

"Specimens were subjected to 1,000,000 pounds compression although the contract calls for but 800,000 pounds. After these proofs, delicate structures such as eggs and nuts were tested in compression, and violin strings in tension. It is unnecessary to multiply instances. It seems safe to conclude that bars and structures up to 400 tons can now be tested with perfect accuracy, and that there is no reason to fear the deterioration of the weighing apparatus.

The machine consists of a double-acting straining cylinder and ram on a carriage at one end, and a movable weighing apparatus at the other end. The two are connected by a pair of 8½″ screws, 48′ long. Nuts driven by shafting move the straining cylinder to different places on the screws, so as to test long and short specimens. The weighing apparatus has been described as a reversed hydrostatic press, having diaphragms instead of pistons. The load is transferred by means of a liquid (alcohol or glycerine) by a series of large diaphragms to a series of small ones, and finally to a system of scale-beams. Thus a weight of 800,000 pounds acting through an inconceivably small space, finally moves a finely graduated indicator at the rate of 1-100th of an inch per pound. It is allowed to move through a space of 2″ and is kept balanced by weights mechanically placed quickly on or off the scale-beam. One pound, in moving the indicator 1-100th of an inch, moves the platform against which the load presses, 1-42,000,000th of an inch. The whole arrangement of the scale-beams, the adding and removing of weights, and the fast or slow but always steady application of pressure are ingenious and convenient in the highest degree. By means of universal joints, the pressure pipes are always connected to the straining cylinder, etc., whatever the position. The steam pump and the accumulator have cylinders and weights respectively for high and low pressures, and the machine receives pressure without pulsation, from the accumulator only, when testing

"The finished metal in the machine weighs 175,000 pounds and includes pieces of 14,000 pounds down to those of which 250,000 would weigh 1 pound. The hydrostatic weighing platform of the machine was tested to 1,500,000 pounds, but so perfectly frictionless is it that a horse-hair under a breaking strain of one pound had to move 24,000 pounds of metal. The workmanship is also remarkable. The 8½″ screws, 48′ long, were fitted to gages within 1-1000th of an inch in diameter throughout their length, and similar accuracy was maintained in other parts."

The boiler plate testing machine of E. & J. Fairbanks & Co., used by the U. S. steamboat inspectors, has a capacity of 75,000 lbs.

The weighing apparatus is a regular platform scale, and may be tested with standard weights to prove its accuracy. The strain is applied to the specimen of boiler plate by means of two screws and worm gears worked by a large gear-wheel and a small pinion. The main beam *A* of the scale carries a poise or weight *B*, which moves on rollers and may be run out to 75,000 lbs. The light beam *C* has a finer graduation on it, running up to 6,000 lbs. The poise *D*, on this beam, is moved automatically by an arrangement of clock-work, *E*, attached to the end of the beam.

The platform of the scale *K* rests on four knife-edges in the main levers *F*, one at each corner of the scale. These levers connect with the double lever *G*, through which the strain is transmitted to the lever *H*, and then through the lever *J* to the steelyard rod of the scale and by that to the beam *A*.

The two columns *L L*, with the cross-head and upper clamp *M*, rest on the platform of the scale. The lower clamp *N* is secured to the cross-head *P*, which is worked up or down by the screws *R R*, turned by worm gears *S S*, on their lower ends, which receive their motion from worms on the shaft carrying the gear-wheel *T*.

To make a test, the specimen *V* of iron to be tested is secured in the clamps *M N*, by steel wedges *W W*. When this is done the specimen is the only connection between the screws and gearing and the platform of the scale.

To begin the test the pinion *U* is shipped out of gear, and the gearing and screws are turned by the handle *Y* until a slight strain is applied to the specimen. when the pinion *U* is shipped into gear. As the strain on the specimen increases the beam of the scale rises, causing the automatic poise *D* to move along on the beam until it reaches the point equal to the strain applied to the specimen, when the beam drops and the poise instantly stops. This operation is continued until the specimen is broken, when the point at which the poise stands will indicate the exact number of pounds which were required to break the specimen.

The testing machine of M. Thomasset (French), Fig. 2417½, avoids the blows incident to the piston of the hydraulic pump when moved by a lever, and has a piston moved by a screw, preventing any jar.

The pressure in the pump is obtained by a hand-wheel on whose shaft is a worm gearing into a cog-wheel on the shaft of the screw whose lower end carries the piston. The pressure in the pump cylinder is transmitted by a pipe to the horizontal cylinder in which is the piston whose rod exerts the tractive force upon the piece under experiment. The other end of the test-piece is held by a clasp connected with the short arm of a heavy lever, the horizontal arm of which rests at its end upon the diaphragm of a cylinder, the water in which transmits the pressure to a column of mercury in the manometer standing alongside

The machine requires but little change for making tests in compression. For flexion the piece is supported between two edges, and a third one at the end of the ram is brought against the middle of the piece.

The following references may be consulted: —

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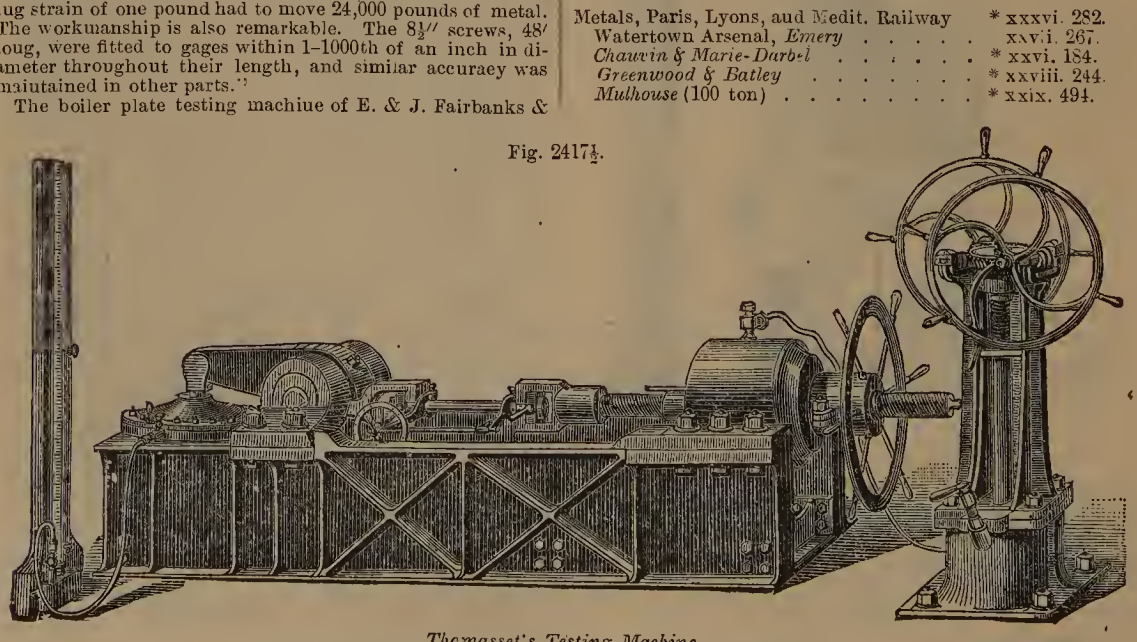
Metals, Paris, Lyons, and Medit. Railway	* xxxvi. 282.
Watertown Arsenal, *Emery*	xxvii. 267.
Chauvin & Marie-Darbel	* xxvi. 184.
Greenwood & Batley	* xxviii. 244.
Mulhouse (100 ton)	* xxix. 494.

Fig. 2417½.



Thomasset's Testing Machine.

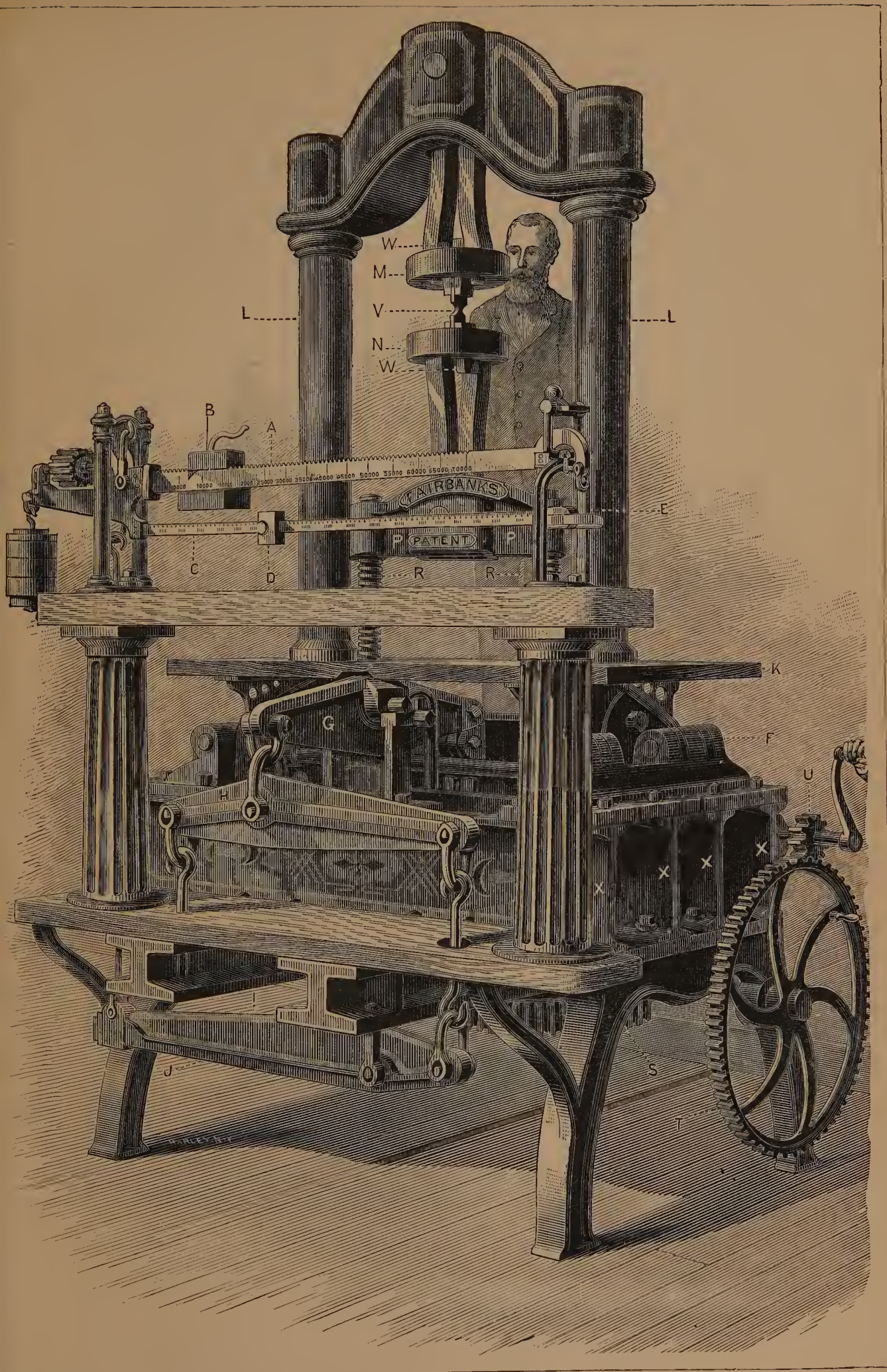


PLATE L. FAIRBANKS' TESTING MACHINE. *See page* 888

Water pipe . . . . . * xxviii. 178, 215.
Lubricants, *Thurston* . . . . . * xxiii. 176.
Ingram & Stapfel . . . . . * xxiii. 28, 33.
Eastern Ry. of France . . . . * xxvii. 234.
Paris, Lyons & Medit. Railroad . * xxvii. 110.
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Metals, *Fairbanks* . . * xxiv., Aug. 21, p. 1.
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Riehle (hydraulic) . . * xx., July 19, p. 9; Aug. 30, p. 1; * xxvi., July 29, p. 9; Dec. 16, p. 1.
Allison (hydraulic) . * xx., Dec. 6, p. 3.
Chauvin & Marie Darbel * xvii., July 18, p. 1.
Watertown, *Emery* . xxiii., Feb. 20, p. 9; Feb. 27, p. 17; xxiv., Dec. 25, p. 15.
Specimens and grips . * xxiii., April 3, p. 9.
Gill . . . . . * xxiii, May 22, p. 1.
Grout, Engl. . . . * xxiii., April 3, p. 3.
Kennedy, Eng. . . . * xxiv., Dec. 4, p. 1.
On metal testing machine xxxv., June 24, p. 3.
Chain cable . . . . xx., Aug. 16, p. 14; Sept. 20, p. 15.
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Wire, *Riehle* . . . . * xxii., Nov. 21, p. 1.
Ritter . . . . . xxii., Nov. 14, p. 20.
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Bailey . . . . . * xxxviii. 130.
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Thurston . . . . . * xxxvi. 342; xxxviii. 130.
Kerosene, *Mead* . . . . . * xxxiv. 402.
Oil (burning) . . . . . xxxix. 25.
Pease . . . . . xlii. 323.
Millspaugh . . . . . * xxxiv. 182.
Lubricants, *Deprez & Napoli* . * xxxvi. 214.
Thurston . . . . . * xxxvi. 89.
Eastern Ry. of France . . * xl. 306.
Boilers, mach., *Howard* . . * xxxiv. 246.
German testing apparatus . . * xliii. 10, 98.
Coin . . . . . * xxxviii. 355.
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Paper . . . . . xxxviii. 69.
Yarn, *Brown & Sharpe* . . . * xxxv. 275.
Tissues . . . . . xxxviii. 74.
Tannin, *Muntz* . . . . . * xxxiv. 182.
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Milk . . . . . * xxxiv. 209.

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Oils, chrono-thermo, for . . * 181.
Adulteration, *Ingram & Stapfer* * 1073.
Metal, *Riehlé* . . . . . * 498.
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Boiler plates, *Huston* . . . December, 1878.
Dumont . . . . . Jauuary, 1879.

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Cables, E. R. Bridge . . . . xii. 13.
Cement, E. R. Bridge . . . * xi. 108.
Fairbanks . . . . . xii. 280.
Lubricants, *Thurston* . . . * ix. 59.
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Springs . . . . . li. 1066.
Lubricants . . . . . li. 397.
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Thurston . . . . . * xii. 186.
Car springs, *Riehle* . . * x. 64.
Lubricants . . . . . * ix. 266, 492; x. 23.
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Wire . . . . . xxv., July 18, p. 13.
Resistance to shocks, *Kent* * xxv., Aug. 22, p. 11.
Metals, *Olsen* . . . . * xxvi., July 2, p. 13.
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Jacob . . . . . * xlviii. 397; * xlix. 5, 28, 64, 377.
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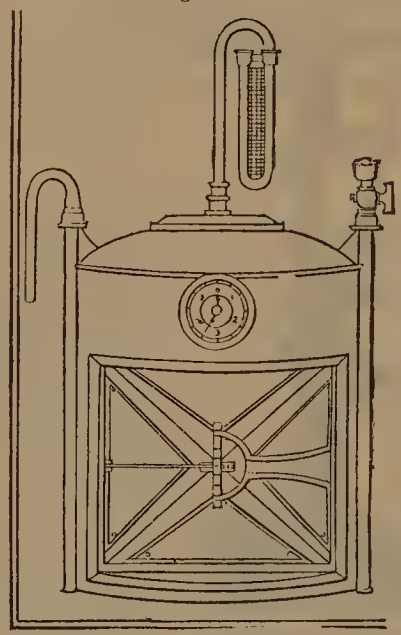
Cloth, Russian . . . xlii. 417.
Metals . . . . . * xli. 264.
Lever, Landore Works * xlii. 21.
Daniel Adams & Co. * xlviii. 412.
Tannin, *Muntz* . . . * xli. 171.

See also DYNAMOMETER.

Test Me'ter. Fig. 2418 shows an experimental or test meter for burners, etc. To insure a uniform and steady light it is made with three diaphragms, and is glazed in front and on top to show its

Fig. 2418.



Test Meter for Gas Burners.

various internal working parts. The dial is so divided as to show hourly rate of consumption by observations of one minute.

The-od'o-lite. A *distance telescope* (theodolite), with a self-registering scale of distances, has lately been invented in Sweden by Mr. Ljungström. The difference between this instrument and others of this class, is principally that the instrument itself effects all the calculations which otherwise are necessary in consequence of the inclined angles, and also that the distances sought are immediately marked on the plane-table. The line of sight upon a leveling-staff having been taken by the telescope which is fixed on a ruler that lies on the plane-table, and can swing round on a fixed needle to a piece as large as the part read off on the leveling-staff, is marked on a movable scale on the instrument, upon which a knob being touched, the point of a needle marks the distance on the paper. The calculating operations are effected by the inclined movement of the telescope, which, by means of a curved line, places the scale at such angles to the vertical plane of the line of sight that the sine for these angles constitute the square cosine for the inclined angle of the telescope, and this sine is then projected towards the movable needle.

Ther-a-peu'tic Ma-chin'e-ry. Fig. 2419, is Dr. Zanders' instrument for treating the muscles of the ankle.

It consists of a sole-plate, to which the foot is secured by means of two sliding stops working on a screw, and adjusted by a small lever. This sole-plate is mounted on a bent axle, the lower end of which is pivoted on to the frame of the machine, and the upper end is connected with a sliding-bar that passes through the spindle of a fly-wheel on the top of the frame. When this wheel is caused to revolve, the axle and sole-plate revolve with it, with an angularity of movement more or less marked according to the distance of the upper bearing of the axle from the center of the wheel spindle. The person operated upon sits in a chair in front of the instrument with his foot secured to the sole-plate as described.

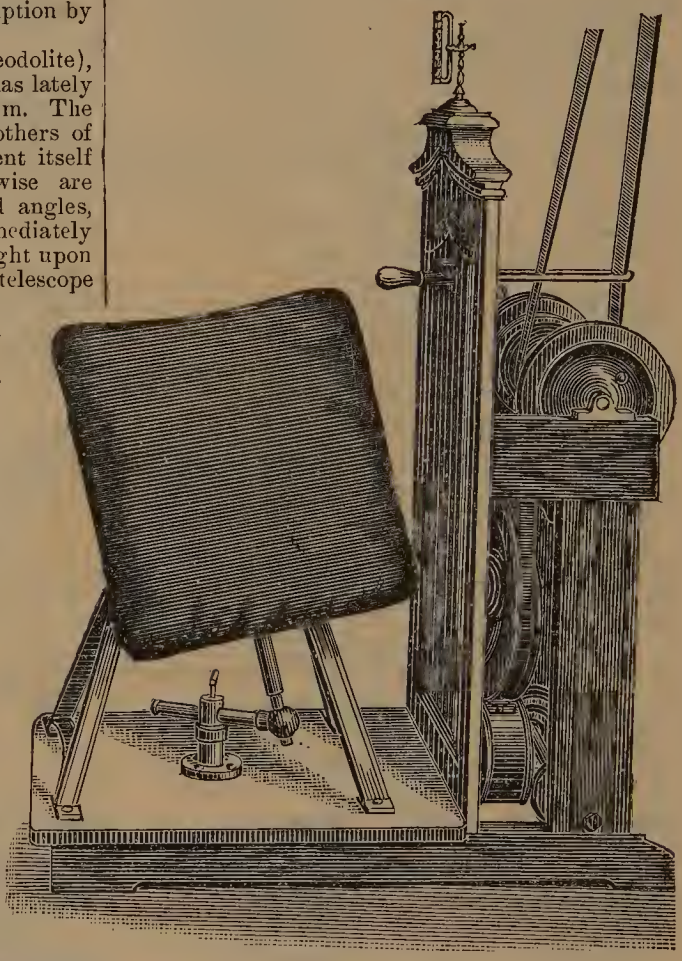
Fig. 2420 represents Dr. Zanders' machine, consisting of a saddle mounted on a shaft, the lower end of the shaft working in a socket on a sliding bar to regulate the motion. The patient, sitting astride of the saddle, is subjected to the influence of a more or less pronounced rolling movement, which brings the muscles of the trunk into action.

Fig. 2419.

Apparatus for Strengthening the Ankles.

Fig. 2421 represents Dr. Zanders' compound machine for acting on the muscles of the legs, and for friction or percussion on any part of the body. The former consists of a horizontal padded cushion, hinged at one extremity and resting on cams at the other, to which a very rapid rotary motion is imparted in such a way that the cushion is thrown into a state of intense vibration. The restorative action of this part of the machine is very remarkable. The other part of the apparatus consists of a vertical spindle sliding in long bearings, and capable of being locked at any height by the set screws shown. A very rapid reciprocating motion is imparted to this spindle by means of the small connecting rod shown on the left-hand side of the engraving. The pad at the top of the spindle is caused to move to and fro with about 600 strokes per minute. This

Fig. 2420.

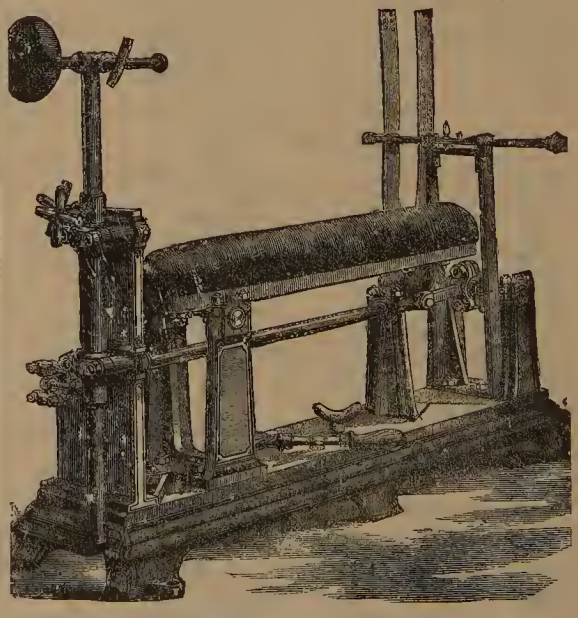


Apparatus for Developing the Muscles of the Body.

apparatus is especially intended for application to the back and shoulder, and different shaped pads are employed according to circumstances.

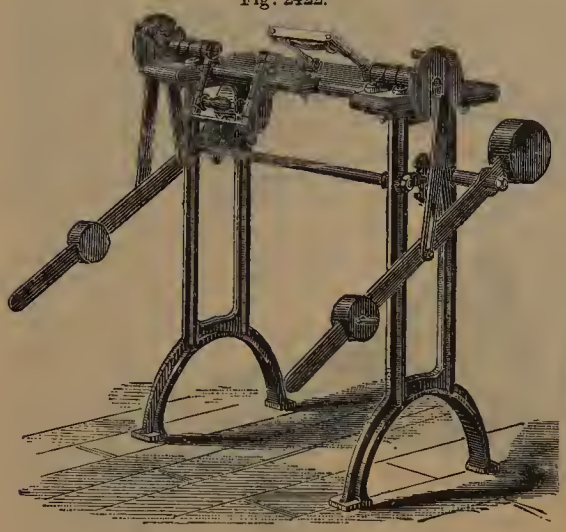
Fig. 2422 represents Dr. Zanders' machine designed for strengthening the wrists. With the fore part of the arm laid flat upon the table of the machine the patient grasps the two

Fig. 2421.



Apparatus for Developing the Muscles of the Legs and Body.

Fig. 2422.



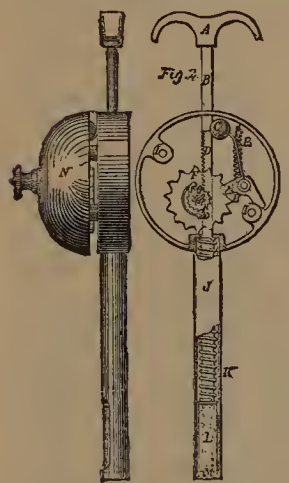
Wrist Strengthening Apparatvs.

handles, and slowly raises them, repeating the operation as long as necessary. These handles are not connected with each other, but are hinged on the inner side to the table, and on the outer are connected to a shaft, on the end of which is a short crank, a pin at the end of which fits into one or other of the notches shown around the periphery of the disk, to which are coupled two rods carrying a transverse weighted bar. The effort required to turn this bar upon its center varies with the position of the balance weights.

Ther'mal A-larm'.

Fig. 2423 is an engraving of a very useful instrument designed and constructed by Mr. Stephen Alley, of Glasgow, Scotland, for giving a prompt indication of a hot bearing.

Fig. 2423.



Thermal Alarm for Hot Boxes.

The apparatus consists simply of a brass tube, *J*, which is placed in a hole bored in the cap of the bearing to receive it, the bottom of the tube touching the shaft. At one side, near the bottom, the tube *J* is partly cut away so as to admit of the ready insertion of a cylindrical plug, *L*, formed of a hard grease, or of a composition which will melt at the temperature at which it is desired that the alarm should be given. To insert the plug *L*, the handle *A* is pulled so as to draw up the spindle *B*, and thus, by compressing the spring *K*, make room between the bottom of the spindle and the bottom of the tube for the plug to be inserted. If the bearing becomes heated, the plug *L* begins to melt, and escapes drop by drop through the hole *M*. As this melting takes place, the spring *K* forces down the spindle *B*, and in so doing gives motion by the rack *D* to the pinion *G*, and thence by the ratchet *O* to the striking wheel *F*. This wheel, as it revolves, operates upon the pallet *H*, and alternately draws back and releases the hammer *C*, which, when released, is made to strike the interior of the bell *N* by the action of the spring *F*.

The instrument gives a number of clear and distinct signals as the composition melts, and can scarcely fail to call the attention of the engineer. It is, moreover, a very simple apparatus, and there is nothing about it likely to get out of order.

Ther'mo-cau'te-ry Ap'pa-ra'tus. (*Surgical.*) An instrument with hollow platinum cautery, which, having been heated to blackness in a spirit lamp, receives a blast of benzine vapor from a spray bellows which heats the cautery to redness, and maintains the heat by an occasional pressure of the air-bulb.

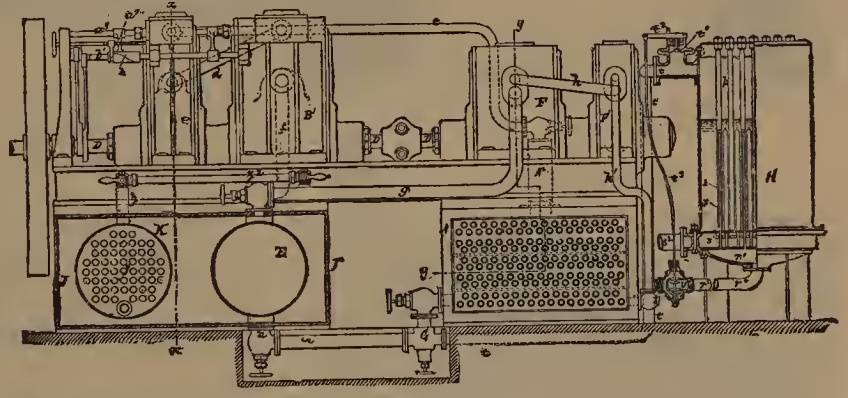
Paquelin's Fig. 432, Part I., *Tiemann's "Armamentarium Chirurgicum."*

Ther'mo-dy-nam'ic En'gine.

Fig. 2424 represents Gamgee's engine, the "Zeromotor." A motor engine with conditions of a closed circuit with a liquid boiling at a low temperature relatively to water transformed into vapor, the molecular energy of which is converted into the mass or molar motion of the piston, so that its initial condition is restored. In this way, in a heat engine, the temperature is extended within which the heat is utilized downward in the direction of the absolute zero instead of upward above the temperature of surrounding objects.

The agent intended to be used is anhydrous ammonia, the boiling point of which at atmospheric pressure approaches closely to 34.4° centigrade. At 0° centigrade its vapor tension is 3,183.34 millimeters, or about four atmospheres, while at 10° it attains to 4,574.03 millimeters or six atmospheres. When the mean temperature attains 20° centigrade no less a pressure is exerted than 6,387.78 millimeters, or nine atmospheres; and at 30° centigrade, or tropical heat, it reaches over 8,000 millimeters, or over 10½ atmospheres in tension. Since at blood-heat 200 lbs. to the square inch is available, it is evident that the usual temperature of ocean or river water is most desirable in practice, and best, it is thought, when below 20° centigrade. The latent heat of ammonia (900° as against 960° for water) is used in developing energy, so as to reduce the amount of rejected heat to a minimum, and obtain a maximum rate of liquefaction.

Fig. 2424.



Thermo-dynamic Engine.

The engine shown in the figure is a double-cylinder rotary engine, *B* being the first or high-pressure cylinder, and *B'* the second or low-pressure cylinder, into which the first cylinder exhausts through pipe *d*. As seen in section, the gas or vapor enters the cylinder *B* through the valve *a* and sliding division-port *a'*, which runs in contact with the eccentric rotary piston *C* in the usual way. The admission-valve is operated from the rocking valve-rod a^3 in the usual way, said rod having an arm, a^2, which bears against the rotating adjustable cut-off cam *b*, whose shaft *b'* is rotated through the medium of eccentrics and connecting-rods from the main shaft *D* in the ordinary manner. The exhaust-port of the first cylinder is shown at *d'* in communication with the exhaust-pipe *d*, which leads to the gas or vapor admitting valve of the second cylinder *B'*. The latter, with its accessories, is similar, except in size, to the first cylinder *B*, the shaft *D* being common to both, and the two cylinders are combined together for operation in the same way as the two cylinders of an ordinary compound or double-cylinder rotary engine.

The pipe *e* conducts the liquefiable gas or vapor to the primary cylinder *B* from the dome A^x of the part *A*, which, for convenience' sake, will be termed the "boiler."

The exhaust-pipe *f* from the second cylinder *B'*, leads

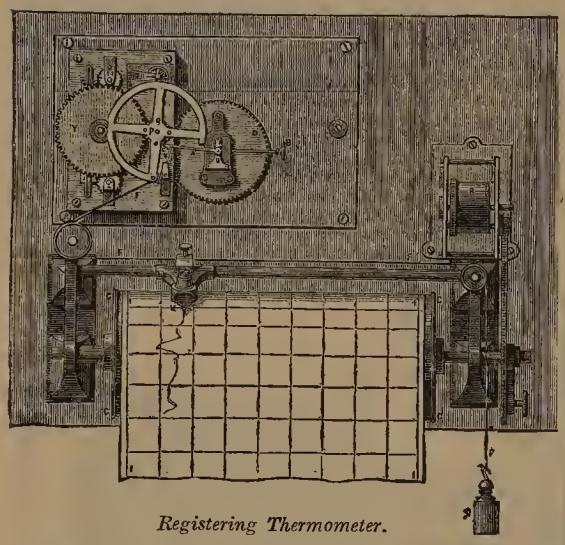
into the closed exhaust-vessel *E*. This vessel receives, through the exhaust-pipe *f*, the liquefied vapor and gas from the second cylinder.

From the upper part of the exhaust-vessel leads a pipe, *g*, to the larger cylinder *F* of a compound or double cylinder rotary pump, *F F'*, driven by the rotary shaft *D*. The smaller or high-pressure cylinder *F'*, with its accessories, is the counterpart of the other, and has its induction-port in communication with the eduction-port of the larger cylinder through the intermediary of pipe *h*. The eduction-port of the smaller cylinder *F'*, communicates through pipe *h'*, with the space in boiler *A*, which receives the liquid from which the motor gas or vapor is to be generated.

Ther-mom'e-ter. Fig. 2425 is a representation of Redier' new registering thermometer which operates through the dilatation in a straight line of two metals, zinc and steel.

If a multiplying mechanism be mounted on a steel bar, 39″ long, and connected with a zinc bar of the same length, the difference of the two expansions per 212° Fah. will be about .08″. This difference is used in the present apparatus to register changes in temperature. The thermometer proper consists of an exterior steel tube, *A*, which carries a toothed wheel, *D*, on which multiplying mechanism is mounted.

Fig. 2425.



Registering Thermometer.

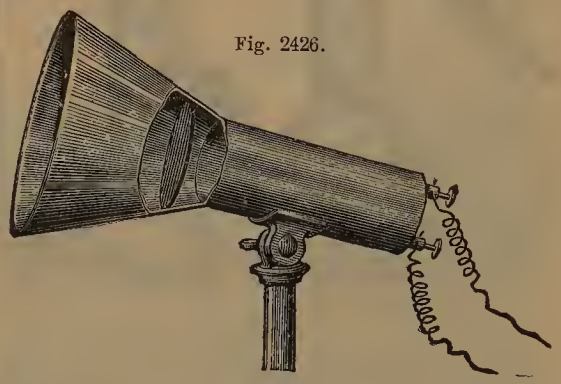
Within the tube *A* is a zinc tube, *z*, which fits closely. These two tubes are connected, and at that point there is a pivot. At the upper portion of tube *z* is a plate, *L*, on which is fixed a small carriage, which carries a pointer adjustable by the milled head *B*. This pointer acts on a pallet, *X*, which is movable, and which transmits any movement of elongation of the bar *z*, to the needle.

On the extremity of the latter is a small hook, *c*. The foregoing part of the apparatus is mounted on a plate in face of a double clockwork movement, and so disposed that it turns from right to left, the exterior steel tube *A* serving as a pivot.

The clock train has two springs *M* and *N*. *M* terminates in a chronometer escapement, and *N* in a very delicate flier, which turns with great rapidity. These two movements are interconnected by the differential train *R R S*. The satellite *S* entrains the axis *A* which on one side carries the pulley *P* on which is wound a cord which moves the pencil, and on the other a pinion, *E*, which engages with the wheel *D* of the thermometer. These two gears are so constructed that the velocity of motor *M* being 1, that of motor *N* will be 2.

We may now trace the operation under a constant temperature. The hook *c* of the needle *A* stops the small fly-wheel. The escapement *E* of the motor *M*, which works constantly, turns the large wheel *D* from right to left. The needle *A* follows the movement and disengages the flier *V* and spring *N*. The latter now being freed, and its velocity being .2, while that of the escapement is .1, tends to turn the wheel *D* from right to left until the needle *A* again catches by its hook, when the same operation is repeated. As the pulley *P* makes the same movement as the wheel, the pencil will trace on paper, if the temperature remains constant, a right line, apparently continuous, but in reality formed of a series of very small zigzags. This movement of constant oscillation is of great importance as regards the sensitiveness of the instrument, as it suppresses the effect of friction at starting and renders the instrument always ready to show instantly the least change of position of the needle. If the temperature augments, the flier *V* remains hooked for a longer or shorter period, proportional to the change of temperature, and as the increase, while turning the wheel *D* from left to right to unhook the flier, also causes the turning of the pulley *P*, the latter will rotate over an angle proportionate to that which the change of temperature causes the needle to pass over. The inverse effect is produced when the temperature falls. The pencil *K*, Fig. 2425, moves on a cylinder, *C*, on which the paper *H* is rolled. The chronometer *R* regulates the movement of this cylinder at a velocity of 0.16″ per hour.

Fig. 2426.



Thermo-telephone.

Ther'mo-phone. (*Electricity.*) An instrument in which sonorous vibrations are produced by the expansion of bodies under the influence of heat. One that produces sound by thermo-action through conversion of forces, or in other words, in rapid expansion and contraction of its circuit by sudden changes of temperature.

Wiesendanger . . . . * "*Teleg. Journal*," vi. 410.
* "*Engineer*," xlvi. 335.
Hughes . . . . . * "*Engineer*," xlv. 344, Fig. 8.

Ther'mo-scope. When chloride of cobalt is dissolved in a definite quantity of strong wine spirit, or alcohol slightly diluted with water, a solution is obtained the color of which varies in a curious manner with the temperature of the surrounding air. Exposed to cold air it develops a bright pink color, which, as the temperature of the air increases, passes through various shades of color, until at last, when the liquid becomes quite warm, it assumes a strong blue or violet blue hue. These color changes are primarily due to the fact that in the cold alcoholic solution the salt appropriates a portion of the water, and when heated, it parts with this water of crystallization or hydration. When the proportions of the chloride of cobalt, alcohol, and water are properly adjusted, and the liquid is sealed in a narrow glass tube, it becomes quite sensitive to change of temperature, and the varied changes of tint when compared with a standardized color scale may serve, within certain limits, as a rough index of the temperature of surrounding bodies, thus constituting the little instrument a thermoscope, if not entitling it to the name chromothermometer, which has been given it. The statements to the effect that changes of color are due to the action of light and electricity or atmospheric humidity, etc., are of course erroneous.

To prepare the solution, dissolve a few crystals of chloride of cobalt (pure) in two or three drachms of warm water, and to this add strong alcohol until, when exposed to a temperature of about 70° Fah., the liquid presents a slaty color, — intermediate between the pink and blue. The proportions will then stand at about twenty grains of the salt to the fluid ounce of alcohol. If too blue, more alcohol or a drop of water may be added to the solution; if it inclines too strongly to the pink a few more grains of the salt.

The solution may be poured into a long, narrow test tube, leaving the upper part of the tube unoccupied, so that it may be subsequently drawn out, and sealed hermetically by means of the blowpipe.

The remarkable properties possessed by some of the solutions of this salt certainly suggest the possibility of applying it to something of greater practical utility than the curious toys in which it has thus far been chiefly employed.

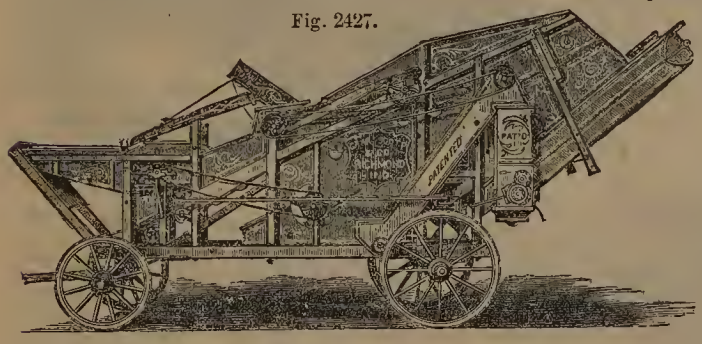
Ther'mo-tel'e-phone. (*Electric.*) Fig. 2426 is a thermo-telephone.

It consists of a thermopile having placed in its collecting funnel a hard rubber disk, as shown in the engraving. A sound made in front of this disk is heard in a receiving telephone connected with the thermopile.

The *rationale* of this is at once apparent when a strip of hard rubber is placed against the lips and bent, so that the strip will be alternately concave and convex. The difference in temperature is very perceptible, the convex surface being cold and the concave surface warm, and, however rapid the vibrations which render the surfaces alternately convex and concave, the result is the same.

Thom'son Bat'te-ry. (*Electricity.*) A modification of Menotti's battery, in which a copper tray

Fig. 2427.



Separator.

replaces the copper plate, and contains the sulphate of copper crystals, and the superstratum of wet sawdust upon which rests the zinc element.

The resistance of the battery is very low.

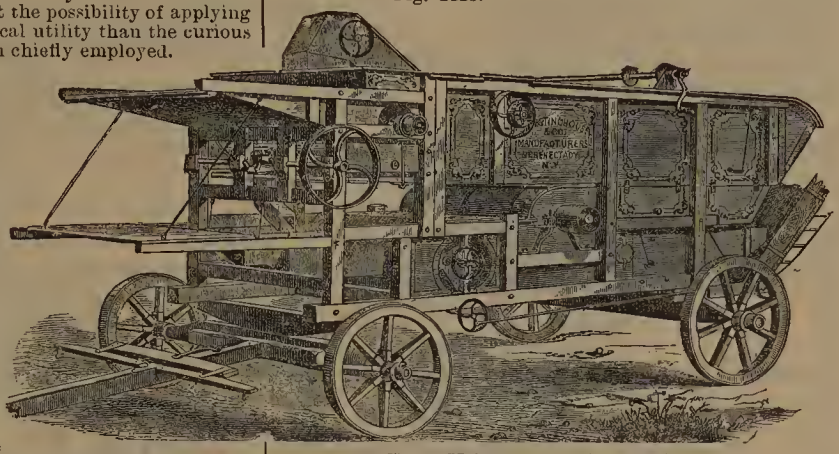
Niaudet, American translation, *130.

Thrash'er. The Gaar separator, Fig. 2427, is an apron machine whose cylinder has from eight to twelve bars as may be desired, and is full curve spiked. The center heads are placed in the cylinders to increase their strength and the power of their momentum, so that they are not readily checked. All the eight and ten-horse machines, both geared and belt, have outside bearings and pivot boxes on the cylinder shafts. A concave adjuster enables the operator to raise or lower the whole concave any required distance while the machine is in motion.

The grain carrier is shaken its whole length by agitators, facilitating the separation of the grain from the straw. Either screw or drag elevators, as desired. All the geared machines have three hitch gear. The tail chain or straw carrier is shaken its entire length by revolving knockers. The shoe is shaken by a half cross belt, dispensing with the fan cog-wheels and shaker shaft. The cylinders have pivot boxes and steel set screws for adjusting the cylinder endwise.

In the Westinghouse combined clover and grain thrasher, Fig. 2428, the process of separation commences at the thrasher. The cylinder delivers the straw to the vibrating separator, where it is first agitated and loosened by a revolving picker, and a farther division of the seed or grains ensues. After passing the picker, the straw is moved back

Fig. 2428.



Clover Huller and Grain Thrasher.

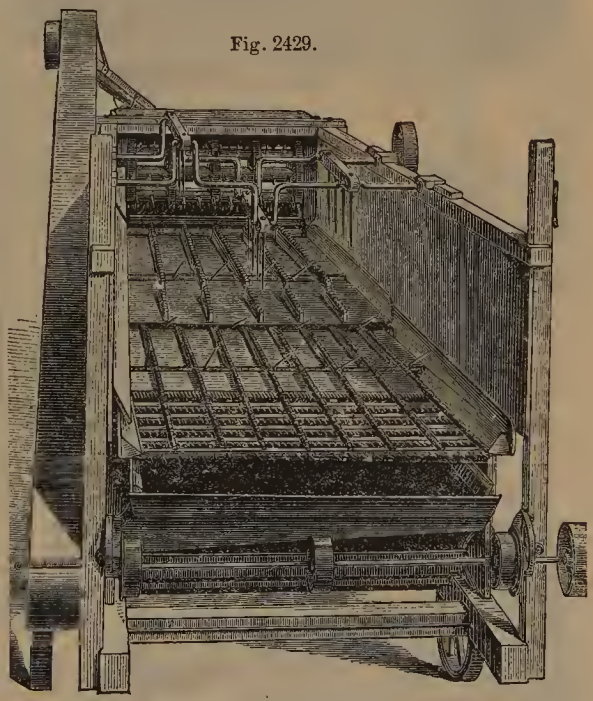
and over a series of shaking forks, which loosen it and permit the grain to reach the open platform, and escape to the grain carrier and fan. The picker, in addition to its help in separating, prevents the straw, with its accompanying seed or grain, from shooting back from the cylinder. The shoe has a short longitudinal action so as not to cause much vibratory motion to the machine.

There is an apparatus for elevating the clean grain or seed as it is discharged from the machine, and emptying either into the measures or bags, making a register of each measure as it is filled.

Thrash'ing Ma-chine'. Fig. 2429 represents an interior view of the Bonanza machine.

It is a vibrator, with large riddle surface, and strong frame, with few wearing points. It has a system of pickers that are useful, especially in damp grain. The front wheels

Fig. 2429.

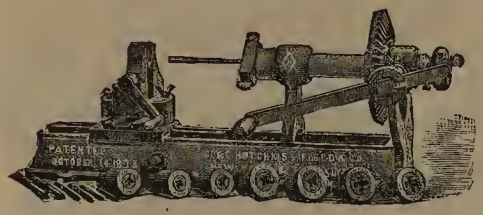


Interior of Separator.

cut under, making it easy to handle. It has many points of separation, and the tables are low.

Thread-cut'ting Ma-chine'. Fig. 2430 represents a self-centering machine for cutting threads in bolts, etc.

Fig. 2430.

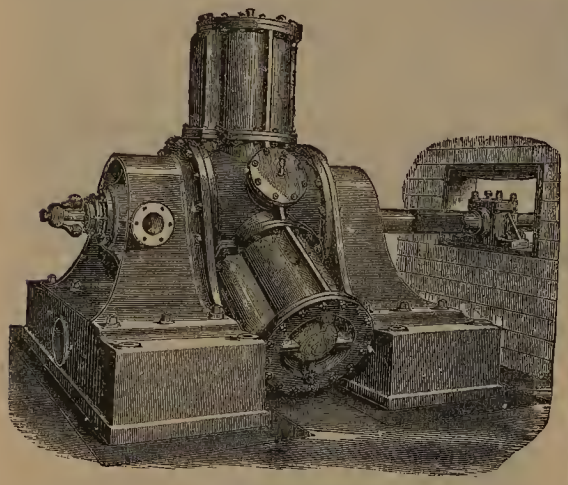


Thread Cutter.

Three-cyl'in-der En'gine. Fig. 2431 represents the Brotherhood engine.

The special advantages secured by the invention are as follows: The eugine will start with the crank in any position, there being no "dead center," and a perfectly uniform motion of the shaft is obtained without the use of a fly-wheel; the connecting rods being always in compression, there is no blow on the crank-pin at either end of the stroke, no matter how loose the fit may be or at what speed the engine may be runuiug. The working parts are entirely inclosed and protected from injury; the lubrication is easily effected;

Fig. 2431.

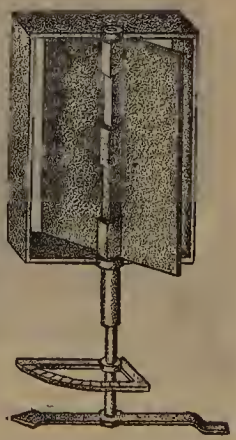


Three-cylinder Engine.

in the steam engine the rotary slide-valve is arranged to cut off at any required degree of expansion, and a governor and reversing gear is readily applied to the steam engine, while the hydraulic engine is made reversible by the addition of Ellington's patent controlling valve.

The high speed at which this engine may be worked, besides developing immense power in proportion to the size of the engiue, permits of its being coupled directly to capstans, rotary pumps, fans, circular saws, screw propellers, centrifugal machines, etc.

Fig. 2432.



Throttle Damper.

The pistons are very deep and guide themselves in the cylinders. The connecting rods are of chilled cast iron in the hydraulic engine and of wrought iron well case-hardened in the steam engine, their crank-pin ends working on a hard gun-metal sleeve fitted to the crank-pin, and their piston-ends working in hard gun-metal sockets in the pistons. The crank shaft is of steel, and the crank, where necessary, is counterbalanced. The slide valve is rotary in the hydraulic and the steam engine, and is balanced, special means being adopted to insure uniform wear.

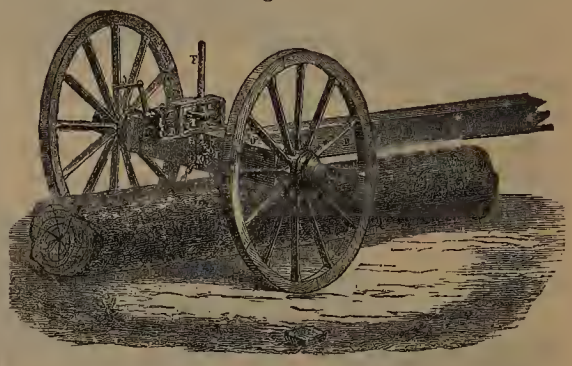
Throt'tle Dam'per. Fig. 2432 is a throttle damper, with arrow and quadrant, for regulating the passage of the flue and registering the same.

Throw'ing Wheel. (*Ceramics.*) The potter's lathe.

The accompanying engraving (Plate LI.) shows the interior of one of the workshops at Sèvres. On the right are shown the throwing wheels, and farther along are men at work molding small objects. On the left is an artist dressing (*grattage*) a green molded object with a scraper. On the throwing wheels, also, are dressed the green objects previously molded there, the operation being known as *tournassage*. See PORCELAIN MOLDING.

Tim'ber Cart. Fig. 2433 is a high wheeled cart for drawing timber. The timber, after the cart is driven over it, is raised to the axle by crank-gearing and tackle.

Fig. 2433.

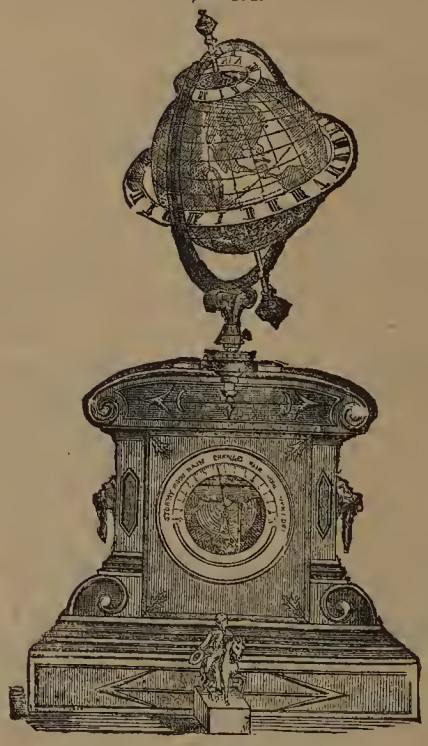


Timber Cart.

Time Globe. Fig. 2434 shows the time globe.

Mr. L. P. Juvet, of Glen's Falls, N. Y., exhibited at the Centennial a novelty in horological manufacture, which was examined by all scientists with interest, and honored with unqualified praise from all skilled in horology. The time globe, as this invention is happily designated, is a horological apparatus by which the hour at any given place is designated and also the corresponding time anywhere and everywhere on the face of the earth. It consists of a terrestial globe, encircled at the equator by a zone dial, inscribed with

Fig. 2434.



Time Globe.

PLATE LI.

PORCELAIN MOLDING ROOM.

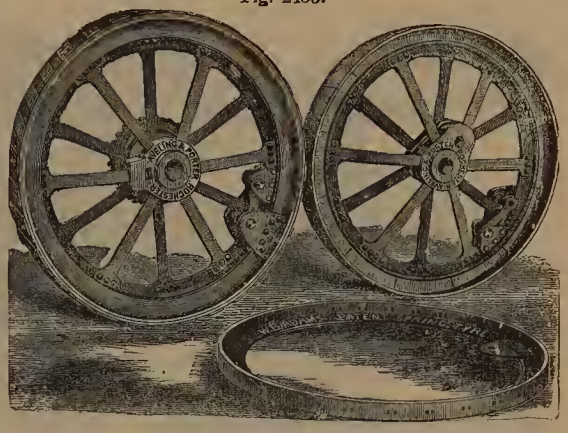
See page 894.

the twenty-four hours of the day and the fractions thereof, while an ordinary clock dial encircles the north pole. The zone dial is stationary, while the terrestial globe revolves on its axis once in twenty-four hours, exactly as the earth does. To set the apparatus in operation for any locality the hands of the clock dial are removed and replaced in position so as to accord with the time indicated by the longitude of that place on the zone dial at the equator. Care must be taken to set the globe in proper sidereal position by the compass, and also that the proper hour of day or night as designated by the zone dial indicates the actual time of day or night, as the case may be. This is easily determined by letting sunshine fall on the globe, and seeing which part is in light and which in shadow. Then set the hands of the clock dial to the actual time of the location, and the terrestial globe revolves on its axis so that the longitude of the location is opposite the same instant on the zone dial. Now the time globe is set, and a glance at the zone dial shows the time opposite every meridian of longitude, and consequently of every place on the surface of the earth. The hands of the clock dial revolve to the right, while the globe revolves to the left, consequently the relative difference in designation of time is maintained, and every meridian of longitude points out its mean time on the zone dial so long as the movement is regulated and kept in proper working order. The movement, which is self-winding in the terrestial globe, is made of two plates, in the center of which stands the main-spring and barrel, with its arbor extending through the globe at the south pole, outside of the meridian ring, where its end is provided with a knot or thumb-piece by means of which the clock is wound up. The shaft of the first wheel extends through the plate and receives a triple wheel intended to transfer to the minute, hour, and globe wheels their proper motions. The axis of these wheels is secured to the upper plate of the works by a flange with pins and screws, extends through the globe at the north pole to the meridian ring, where it is firmly secured by a set screw, and forms with the arbor the axis upon which the globe revolves.

Tire.

Fig. 2435 represents Adams's spring tires for locomotive wheels. To an inner tire of strong spring iron are riveted

Fig. 2435.



Tire for Locomotive Wheel.

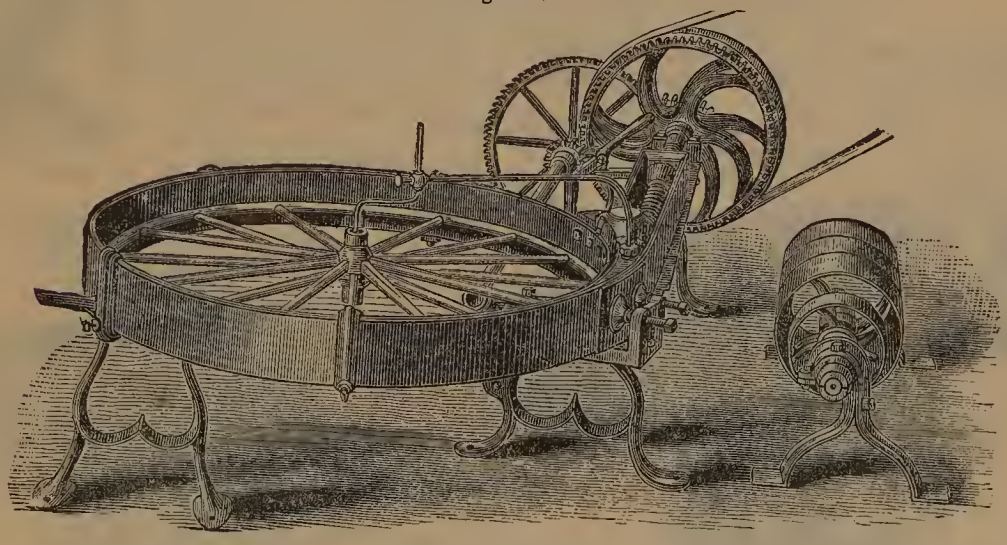
the wrought-iron spokes, while the outer iron consists of a hoop of suitable thickness, stiffened by angle-iron rings running around its edges, and faced with diagonal plates for giving the wheel increased adhesion, as well as for carrying the angle-iron paddles occasionally made use of on soft ground.

Solid blocks of india-rubber between the tires serve the purpose of a spring to the engine without interference with its gearing. The outer and inner tire of each wheel are coupled by a drag link to prevent friction on the rubber blocks.

Tire Set'ter.

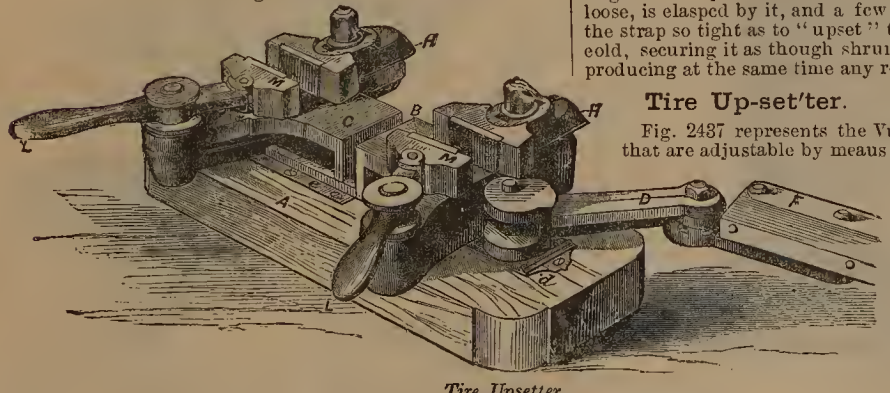
The West tire setter, Fig. 2436, is arranged with a strap made up of several thicknesses of thin steel, and capable of being "set up" by a powerful screw, worked by a belt. A

Fig. 2436.



Tire Setter.

Fig. 2437.



Tire Upsetter.

wagon-wheel placed within this ring, with its tire perfectly loose, is elasped by it, and a few turns of the screw draws the strap so tight as to "upset" the tire, although perfectly cold, securing it as though shrunken in the usual way, and producing at the same time any required dish of the wheel.

Tire Up-set'ter.

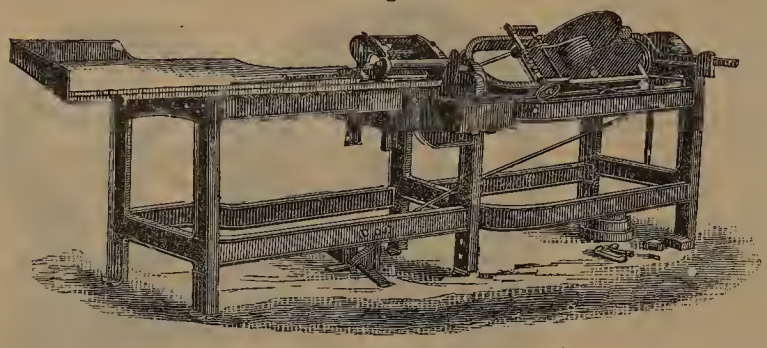
Fig. 2437 represents the Vulcan machine; has levers that are adjustable by means of a joint. They allow of grasping and holding various shapes of iron, from $\frac{1}{8}$" to $3\frac{1}{2}$" wide.

To-bac'co Spin'ning Ma-chine'.

Fig. 2438 shows the Robinson tobacco spinning machine.

A machine to spin small twist, constructed to run

Fig. 2438.

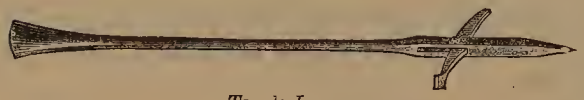


Tobacco Spinner.

at great speed, light, and without strain, making a fine cord. The rollers pass the twist between them, so as only to require winding up by the bobbin; this is done by a slight self-acting friction which is of a uniform tension and under the immediate control of the spinner. The machines are made to suit different sizes of twist, from 3-16″ to $\frac{5}{8}$″ and for any sort of tobacco. The quantity which can be spun per day varies from 75 lbs. to 250 lbs., according to size, etc. They will work either long or short-filler, there is no strain on the twist, and shorts can be spun if desired. The tobacco when spun passes on to the bobbin, which when full is very easily replaced by an empty one.

Tog'gle Iron. A harpoon, Fig. 2439, with latch that prevents retraction.

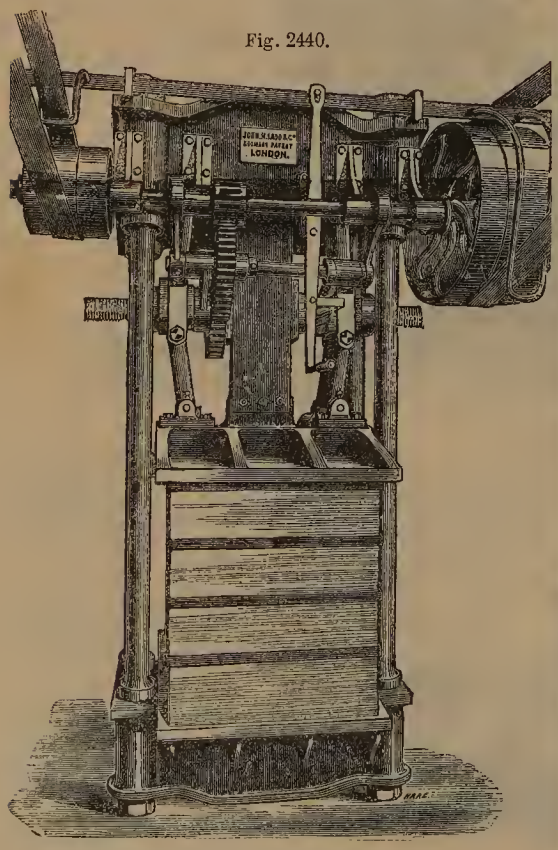
Fig. 2439.



Toggle Iron.

Tog'gle Press. A press in which the power is obtained by the action of one or more toggle joints. See p. 2586, "*Mech. Dict.*"

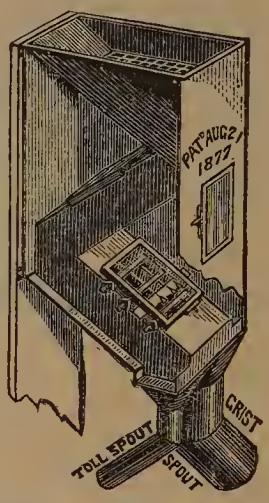
Fig. 2440.



Toggle Press.

Fig. 2440 represents the Boomer & Boschert. The principle by which its accumulative power is acquired is the combination of four levers acting upon toggle joints, either to approach or to diverge, according to the direction of such rotation, with uniform motion. The power is controlled by a standard fastened to the follower sliding through the head block between the arms, maintaining the follower on a level, and preventing an endwise movement of the screw. The gross load is transmitted through the toggle joints to the top frame or head block connected with the base by the wrought-iron pillars. The power accumulates at each revolution of the screw, the follower decreasing in motion in precisely the same ratio as the power increases, so that at last the accumulated power is almost irresistible. The development of the pressure and the increase of the resistance being so nearly equal, it requires but little motive power to work it. Thus one man can work a press of 150 tons, and for the press up to 600 tons it requires but from one to two horse-power.

Fig. 2441.



Toller.

Tol'ler. (*Grist Mill.*) The Tom Thumb toller, Fig. 2441, is an automatic divider of the toll from the grist.

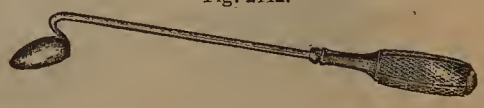
Tom'kin Post. (*Grain Mill.*) The post supporting the pivot end of the bridge-tree.

Tom Thumb Batte-ry. (*Electricity.*) A small and simple battery made of a couple of plates of zinc and lead placed in a tray with a solution of sulphate of copper, and furnished with binding posts for connections.

"*Scientific Amer. Sup.*" 2489.

Tongue Hold'er. (*Dental.*) Fig. 2442 represents Dr. Flagg's tongue

Fig. 2442.



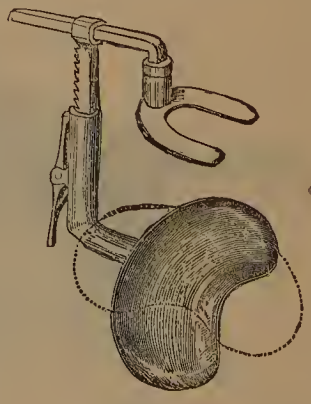
Tongue Holder.

holder for restraining the tongue from interference while the teeth are being operated upon by the dentist. See Tongue Depressor, p. 2590, "*Mech. Dict.*"

Tongue Hold'er and Duct Compres'sor. Fig. 2443 represents Dr. Smith's tongue regulator and duct restrainer. By the use of this instrument the tongue is clamped down and held in position as desired.

The sublingual and submaxillary ducts are closed by placing upon them pads of bibulous tissue paper before applying the compress; a pad of paper or a napkin

Fig. 2443.



Tongue Holder and Duct Compressor.

should be placed on the tongue before adjusting the instrument in position for use.

To'nite. Dry nitrated gun cotton. Density 1.50, about the same as dynamite, and occupies in a blast-hole ⅔ the space of compressed gun cotton. Sold as a dense dry cartridge.

"*London Mining Journal*," 1878. See also "*Engineer*," 1878.

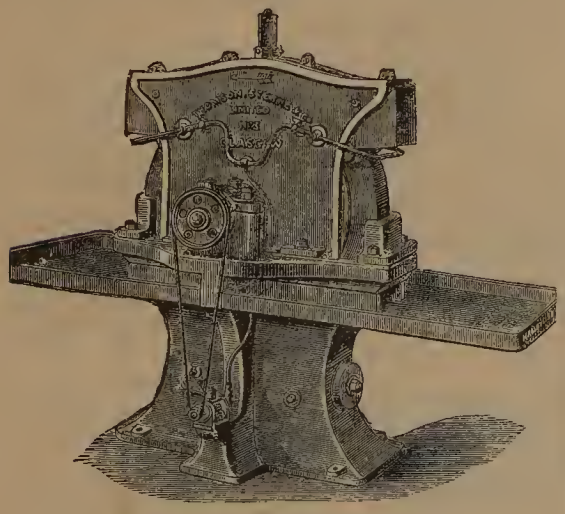
As made at Fernham, England, it consists of finely divided or macerated gun cotton compounded with about the same weight of nitrate of baryta. The gun cottou itself is mainly common cotton waste steeped in nitrie acid, and on the exeess being forced out by a hydraulic press or otherwise, it is left some time for digestion in vessels of clay. While moist, it is macerated between crushing rollers and then washed. The *rationale* of the latter process is a secret.

As stated above, tonite cousists of this macerated gun cotton intimately mixed up between edge-ruuners with about the same weight of nitrate of baryta. It is pressed into candle-shaped cartridges, with a receiver at one end for the reception of a fulminate of mercury detonator.

Tool Grind'er. A machine for sharpening and polishing tools.

Fig. 2444 is an emery grinder for heavy tools, made by Thomson, Sterne & Co., of Glasgow, Scotland, and is shown with a simple rest for the tools, but is also supplied with special slide-rests for grinding tools in holders. The water is thrown upon the emery-wheel by perforated pipes, which are shown branching to each side from a pipe which rises alongside of the bearing from a small rotary pump driven by a cord from the wheel-shaft.

Fig. 2444.



Thomson, Sterne & Co.'s Tool Grinder.

Tool Mark'ing.

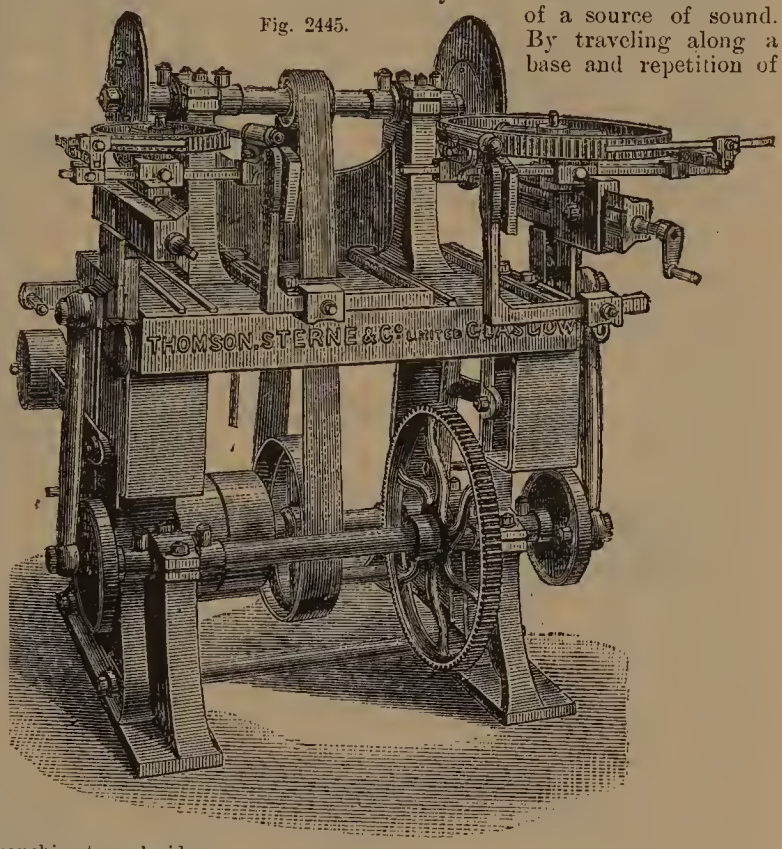
To inscribe your name on steel tools cover the part to be marked with a thin coating of tallow or beeswax. Then with a sharp instrument write the name in the tallow, cutting clearly into it. Then fill in the letters with nitric acid. Let it remain from one to ten minutes. Then dip in water and rub off, and you will have the mark etched.

Tooth Clean'er. A machine for dressing up the teeth of cog wheels.

Fig. 2445 represents Thomson's wheel tool-cleaning machine for dressing between the teeth of spur-wheels. Two wheels can be operated on at once by two emery wheels fixed on each end of the spindle, driven by the counter-shaft.

To'po-phone. An instrument invented by Prof. Alfred M. Mayer to determine the direction of a source of sound. By traveling along a base and repetition of observation it may also, by calculation, be an indicator of distance of the source of sound.

Fig. 2445.



Tooth Cleaner.

Described by the inventor in the "*American Journal of Otology*" for October, 1879.

The instrument has been made in two forms: the stationary and portable.

In the former case, when used on board a vessel to ascertain the direction of a fog-horn or bell, the apparatus has a vertical rod passing through the roof of the deck-cabin, on the upper end of which is attached a horizontal bar carrying two adjustable resonators. Below these is a pointer, set at right angles with the horizontal bar. Rubber tubes pass through the roof of the cabin and connect the resonator with a pair of ear-tubes. A handle attached to the vertical rod serves to turn it either way, the direction being indicated by the pointer. The resonators are by this means adjusted so that they are brought simultaneously upon the wave surface; that is to say, the horizontal bar is a chord in the spherical wave surface, of which the fog-horn, for instance, is the center; the pointer then represents a radius, or, in other words, coincides in alignment with a line drawn from the place where the sound is produced through the plane of observation.

By sailing the ship at a measured distance at an observed angle from the radius line thus found, a second radius line may in like manner be found, and the distance between the two points of observation is the base-line of a triangle, of which the two convergent radii are the sides. From these data the distance of the fog-horn is readily computed.

The true line of direction is evineed by the clearness of the note imparted, any lateral deviation from the line giving rise to opposition and consequent neutralization of the respective sounds. The connecting tubes being of the same length, when the resonators receive the sound at the same exact instant, the sound pulses, acting together, are reënforced to the ear.

On trial it was found that the direction of sound could be ascertained within one point, say 10°.

The description of the action of the stationary form applies, *mutates mutandi*, to the portable form.

"*Iron Age*" . . . . . xxv., March 4, p. 5.
"*Manufacturer & Builder*" . . xii. 79; *253.

Tor-pe'do. Torpedoes have been divided into *defensive* and *offensive*, and the former into *electrical* and *mechanical*.

I. Defensive:

1. The *electrical* includes those fired by the closing of a circuit, either by a party on the look-out or by contact of the vessel. They are defined as: *a*. "Electro-contact torpedoes"; *b*. "Torpedoes fired by observation."

a. The electro-contact torpedo is placed so that a vessel running against it will set in motion the electrical apparatus; but it can be rendered harmless as against a friendly vessel by an observer on shore, and as instantly restored to activity by the same agency.

A torpedo fired by contact can be much smaller in its charge than one fired by observation, as the proximity of the latter to the enemy can only be approximately determined, and it must be sufficiently powerful to be fatal to vessels within a considerable area.

b. In the torpedo fired by observation, charges of powder from 500 to 2,000 lbs. are used, to be fired when the vessel is over the spot where such is sunken, to be determined by means of collimators or telescopic observing arcas.

The electric torpedo is not itself explosive, and a blow or a fall is harmless, except as it may injure the envelope and cause a leak.

It is preferably lighted by the platinum wire fuse, which is simple, safe, and certain, and can be tested electrically, both before and after it is placed in the torpedo, without the fear of explosion.

The charge may be gunpowder, gun cotton, dynamite, etc. The British prefer gun cotton; America and Sweden have experimented largely with dynamite; Prussia, during the war with France, 1870, 1871, used dualine, another nitroglycerine preparation; Austria used gun cotton.

2. The *mechanical* includes those exploded by concussion.

Anchored Torpedoes. — The *shell* torpedo is used for the defense of obstructions in rivers and harbors. It is bolted in an inclined position to a frame which is sunk upon the obstructions and loaded with stone.

The *arm* torpedo is of the buoyant anchored class. As the bottom or side of a ship comes in contact with one of the three arms which radiate like spokes at angles of 120° with each other, the hammer is unshipped, and the spring drives it upon the caps, which explode the charge.

The *percussion* torpedo has a loose lid which is displaced by the contact of the bottom or side of a vessel, and, falling off the torpedo magazine, pulls upon some wires which spring the hammers and explode the charge. This was one of the earliest in use during the late war, and continued to be employed to the last. It is understood to have done more execution than any other during the war.

The *submarine* torpedo consists of a water-tight tank of common powder, anchored by two chains below the surface of the water and exploded by electricity, contact, clock-work, or what not. The term is general rather than descriptive, in contradistinction to terrestrial or military torpedoes, and perhaps to those exposed on the ends of spars. See Spar Torpedo.

Into the center of the tank pass the terminals of two insulated copper wires, a fine platinum wire passing through a small cartridge of fine rifle powder in the middle of the charge.

Mechanical torpedoes of various forms are described on pp. 2599, 2600, "*Mech. Dict.*"

a. Drifting.
b. Anchored.
c. Boom or spar, Figs. 6554-6556.
d. Maneuvered.

II. Offensive:

These may be divided into—

1. The *fish* torpedo, of which Whitehead's (see Plate LII.) is the principal example.
2. Drifting torpedoes.
3. The sea torpedo.
4. Torpedo boats.

1. The fish torpedo has a steel or iron fish-like case; the front fitted with a percussion fuse communicating with the charge. The stern of the Whitehead torpedo has machinery for working a screw by compressed air, which is in a reservoir amidships. It is launched from shore or from a ship, and pursues its course under water.

The Lay torpedo (see Plate LII.), p. 2599, "*Mech. Dict.*," uses condensed carbonic acid gas. A cable containing the electric wires pays out as the torpedo proceeds; two of these are for governing the machinery and the third for exploding the charge.

Col. Lay's torpedoes are still extensively used in Europe, especially in Russia, and his star torpedoes in the Russian navy; and two of his torpedo boats are owned by the United States government. This boat, as recently improved, can be controlled at a distance of more than a mile and a half.

The Ericsson torpedo is launched from a vessel, and has an india-rubber tube which pays out and conveys compressed air, which furnishes the motive power. Fig. 6558, "*Mech. Dict.*," described on page 2599.

2. Drifting torpedoes have cases of various kinds, and are abandoned to drift in a current or with the tide.

3. The sea torpedo is used in action, and is a case maneuvered by lines from the yards of the vessel.

4. Torpedo boats are of several kinds (see p. 2601, "*Mech. Dict.*"), and either carry the torpedo on a spar or a projection from the stern, or are arranged for launching fish torpedoes.

The *turtle* torpedo is so named from its resemblance to that animal, and is placed to prevent raking or grappling for a moored boom torpedo, being connected with the latter by a rope 130′ or 140′ long.

The Whitehead fish torpedo is a spindle of revolution, made of iron and steel, about 14′ long, and having a diameter of 14″, and carries a charge of 20 lbs. of dyuamite. It is driven by a propeller and a compressed-air engine, the air being contained in a reservoir. A rudder regulates the depth and the direction, being adjustable so as to direct it along any curve required. The after half has projecting longitudinal ribs, which are extended aft to the ring which surrounds the propeller, and afford rests for the torpedo in launching. The bow, which contains the explosive, may be separated from the body of the torpedo and be stowed in a magazine. The extreme point forward has an arrow-head to stick into the side of a wooden vessel.

The results attained have been speeds of from 10½ to 7½ knots per hour for distances of from 720′ to 4,500′; but more lately one has been made to run 600′ at the rate of 17 knots, or a mile at the rate of 10 knots. This trial was witnessed by some U. S. officers at Fiume, and is reported in the "*Army and Navy Journal*" of November 28, 1874. It is described in the "*Army and Navy Journal*" as cigar-shaped, made of ⅛″ inch steel, and 19′ long, 15″ in diameter. It has a six-bladed screw with expanding pitch, and four T-iron angle pieces running three fifths of its length. A pistol at the bow is exploded by concussion, and in addition there are three triggers projecting from the bow, which may explode the charge by contact with a vessel. This torpedo had no apparent steering apparatus, traveling only in the direction given to it at starting by the adjustment of the rudder. The pressure in the reservoir is 1,000 pounds per square foot.

The action of current is taken into consideration in launching, as well as the rate of motion of a vessel at which it may be launched. It can be launched by projection from a tube by compressed air, or by hand by simply starting.

Mr. H. F. Hicks has designed a gun that is used, like that of Ericsson, to propel torpedoes under water, but the motive power is steam instead of gunpowder. The gun has a number of steam chambers connected with the bore, so as to use steam pressure successively and act on the principle of accelerated velocity, on the plan of Haskel's gun.

Myron Coloney, of St. Louis, has a system of floating torpedoes, with magnets secured to them (see Plate LII.). The magnets are intended to securely attach the torpedoes to iron vessels before exploding.

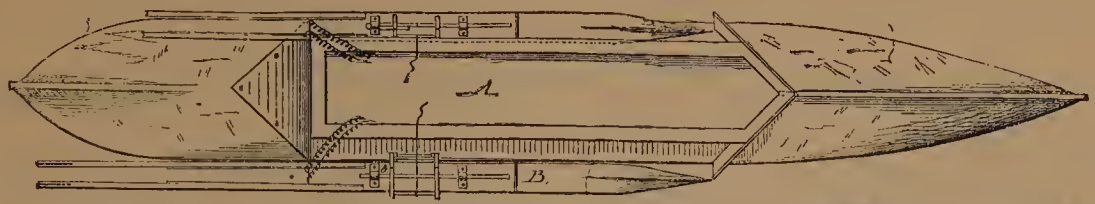
The torpedo invented by Asa Weeks (see Plate LII.) is believed to be the most powerful and destructive rocket torpedo yet produced. The torpedo proper is a triangular float, having two side wings extending astern, where they are provided with keels or cut-waters. The wings serve to maintain the balance of the torpedo, as it grows lighter from the combustion of the rocket composition, and the cut-waters serve as guiding rudders. The bursting charge of dynamite is in the front compartment of the torpedo, and is exploded by a percussion primer on contact with an obstacle, or is blown up by fire from the rocket charge after the expiration of a suitable interval.

The torpedo is slung at the davits of a steam launch made expressly for the purpose. The prow of the torpedo rises a little above the general surface line to prevent the tendency to run under when striking a wave. The rocket is carried in cylindrical chambers, and the powder is cored out eccentrically to the inclosing casing. This arrangement of the powder secures a nearly uniform combustion. The combustion chambers are surrounded by some refractory substance to prevent injury to the float and danger to the bursting charge. The rocket charge is ignited preferably by an electric ignitor, and the torpedo detaches itself from the davits, being hung thereto by a loop and pin. The rocket runs on the surface of the water, and can be made to travel at the rate of 100′ per second for 1,500′. The cost of a rocket carrying 50 lbs. of dynamite has been reduced below $500.

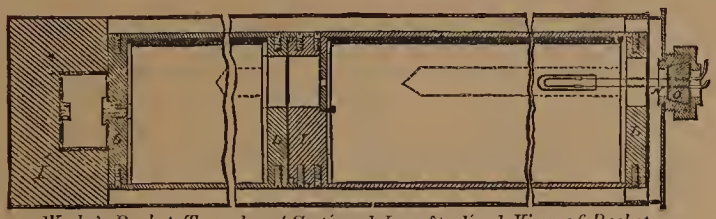
This torpedo has been adopted by the United States government after full investigation of its merits.

Mr. Weeks is the inventor of a star torpedo operated from the deck of a fast steam launch. He has also a floating or drifting torpedo that is detached from the float when it encounters an obstruction and explodes after sinking a few feet. It is intended to be set adrift in rivers and tideways where the current sets in the direction of a hostile fleet.

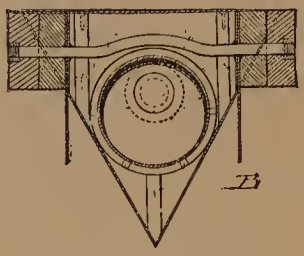
Col. Mallory's rocket torpedo has an ingenious arrangement of the rocket charge to secure uniform combustion. The charge of slow powder is made up into a large number of small cartridges, placed in holes radiating from a central chamber in a cylinder of fire clay. The cartridges all burn at once, and as only the end of each cartridge is presented to the flame the extent of the burning surface remains the



Weeks' Rocket Torpedo.

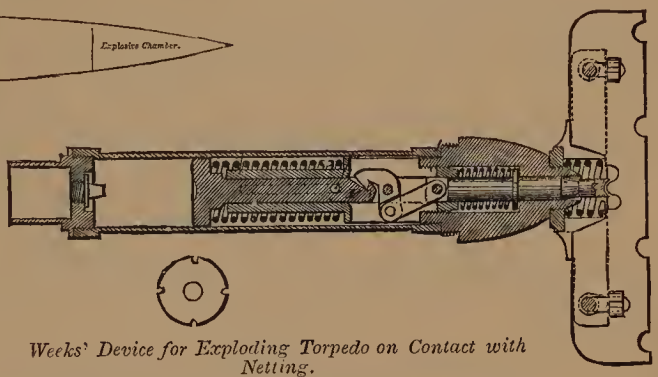


Weeks' Rocket Torpedo. (Sectional Longitudinal View of Rocket and Explosive Chambers.)

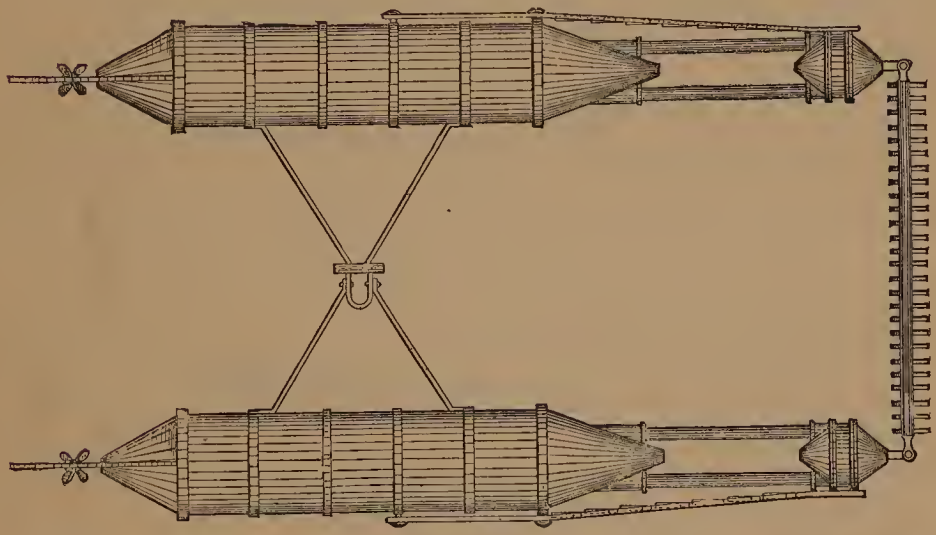


Weeks' Rocket Torpedo. (Sectional Transverse View.)

Whitehead Torpedo.

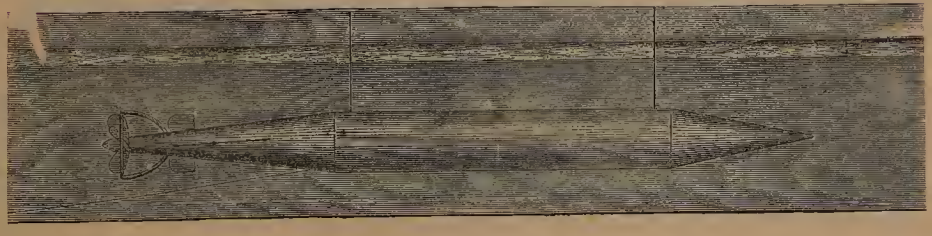


Weeks' Device for Exploding Torpedo on Contact with Netting.



Coloney Torpedo.

Coloney Projectile Torpedo.



Lay Torpedo.

same, and the decrease in weight by burning is regular. The air is permitted to escape at a determined rate from the air vessel that surrounds the torpedo, and so the loss in flotation equalizes the loss in weight due to combustion, the torpedo thus being advanced in a predetermined depth under the surface of the water.

The torpedo-boat invented by Bushnell, of Conn., in 1777, proved the feasibility of this style of warfare by blowing up a British tender in the harbor of New London, and but for the awkwardness of the person in the boat, would have blown up the "Eagle," a British sixty-four gun ship in New York harbor. This same person, in the same year, set a squadron of kegs afloat in the Delaware river, arranged to explode upon coming in contact with anything. They were set adrift too high up, so that they approached in the daytime. One boat was blown up. The British from the shore fired on them, which gave rise to the famous Battle of the Kegs, of which so much sport was made by our revolutionary writers.

The usual arrangement of booms, spars, and nettings for resisting the attacks of torpedo boats having been found ineffectual in the British navy, a magneto-electric light, contrived by Mr. Wilde, of Manchester, for the purpose of detecting the approach of a torpedo boat at night, has been tested. The carbon points and lens are arranged in a box which has vertical and horizontal adjustments permitting the beam of light to be rapidly directed to any point of the horizon and upon any object within the limit of its vertical range. Two steam pinnaces fitted with torpedo arrangement were employed to make a sham attack upon the "Comet," which was provided with one of these machines, but were in each instance discovered before approaching within a mile, the direction of the proposed attack being previously unknown.

(*Fishing.*) Torpedoes exploded under water are employed on the southern coast of the United States for catching fish. The same plan is used by poachers for salmon and trout in Scotland and in trout ponds of New Jersey. The torpedo is exploded by a portable battery.

Cartridges or torpedoes of dynamite, nitro glycerine, etc., are sometimes exploded in schools of fish, and destroy great numbers.

The Austrian torpedoes are well described and illustrated in Barnard & Wright's report, Engineers' Dept. U. S. Army, on the "*Fabrication of Iron for Defensive Purposes*," Washington, 1871.

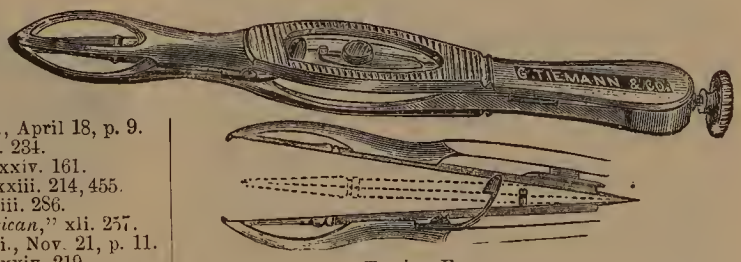
Anchored, electric, fuses.

Harvey torpedo,* p. 195, Appendix X. Barnard & Wright's Report, U. S. Engineers, 1871.

Torpedoes of various kinds, electric, contact, navigating, floating, moored, etc. * "*Manufacturer & Builder*," ix. 181.

Torpedo.
* "*Sc. Amer.*," xxxvi. 295, 327, 402; xxxviii. 82
* "*Sc. Am. Sup.*," 337, 388, 479.
American.
* "*Iron Age*," xix., June 28, p. 24.
And boats . . . . "*Iron Age*," xxi., April 18, p. 9.
Armor . . . . . * "*Engineer*," xlv. 234.
Batteries for . . . . * "*Engineering*," xxiv. 161.
Electro-mechanical . * "*Engineering*," xxiii. 214, 455.
Ericsson . . . . . * "*Engineer*," xlviii. 286.
* "*Scientific American*," xli. 257.
"*Iron Age*," xxii., Nov. 21, p. 11.
Fuses, joints, etc. . . * "*Engineering*," xxiv. 219.
Lay . . . . . * "*Iron Age*," xxv., June 10, p. 1.
* "*Engineer*," xlix. 244.
* "*Scientific American*," xli. 249.
Harvey . . . . . * "*Engineering*," xxiv. 391.
* "*Scientific American Sup.*," 1792.
Locomotive, *Whitehead*, etc. . . . . "*Van Nostrand's Mag.*," xvi. 158.
Mathieson's mechanic. * "*Engineering*," xxiii. 406.
McEvoy, mechanical * "*Engineering*," xxiii. 407.
Mechanical primer for, *Abel*, Br. . . . . * "*Engineering*," xxiv. 83.
On . . . . . * "*Engineering*," xxi. 15, 22, 96, 153, 184, 224, 404, 475, 549.
Porter . . . . . * "*Scientific American*," xxxvi. 159.
Signaling and firing apparatus . . . . * "*Engineering*," xxii. 303.
Series of admirable papers . . . . . * "*Engineering*," xxiii.
Spar . . . . . * "*Engineering*," xxv. 14, 127.
Spar locomotive . . * "*Engineering*," xxv. 210.
Testing table . . . * "*Engineering*," xxii. 367.
Warfare . . . . . "*Scientific American Sup.*," 1087.
* "*Scientific American*," xxxvii. 39.
Whitehead . . . . * "*Scientific American Sup.*," 731.
Balloon torpedo. . . . * "*Scientific American*," xxxviii. 287.
Torpedo boat . . . . * "*Scientific American*," xli. 379.
"Alarm" . . . . "*Van Nostrand's Mag.*," xv. 477.
"*Scientific American*," xxxiv 89.
Spar, *Yarrow*, Br. . . * "*Engineering*," xliv. 419.
Steel, for Whitehead torpedo . . . . . * "*Scientific American Sup.*," 1837.
Ericsson . . . . . "*Manuf. & Builder*," x. 229.
Fish, Br. . . . . "*Iron Age*," xxi., May 23, p. 15.
Garrett, Br. . . . . "*Van Nostrand's Mag.*," xix. 381.
"*Iron Age*," xxii., Oct. 17, p. 9.
Herreshoff . . . . "*Scientific American*," xl. 105.
"*Engineering*," xxvii. 32.
Lay . . . . . "*Iron Age*," xvii., May 4, p. 3.
"*Telegraphic Journal*," iv. 161.
Mortensen . . . . * "*Scientific American*," xl. 119.
Russian . . . . . * "*Scientific American Sup.*," 1314.
Thorneycroft . . . * "*Engineering*," xxx. 237.
"*Van Nostrand's Mag.*," xvii. 92.
Ten Eyck . . . . * "*Scientific American*," xl. 50.
"Destroyer," *Ericsson* . . . . . * "*Engineer*," xlvi. 340.
"Lightning," *Thorneycroft* . . . . * "*Engineer*," xliii. 337.
Boat engine, compound, *Thorneycroft*, Br. . * "*Engineering*," xxx. 243.
Ericsson . . . . . * "*Scientific American*," xl. 63.
Boat and engine, Russian * "*Engineering*," xxvi. 327.
* "*Scientific American Sup.*," 2462.
Defense . . . . . * "*Scientific American Sup.*," 1616.
Defense, Br. . . . . * "*Engineering*," xxiv. 279.
Experiments, Engl. . . * "*Scientific American Sup.*," 1908.
Thorneycroft (Cherbourg) . . . . . * "*Scientific American*," xxxvi. 239, 246.
On ship's hull . . . * "*Scientific American Sup.*," 1380.
Circuit closer, *Atkinson* * "*Engineering*," xxvi. 443.
Charge cases . . . . * "*Engineering*," xxii. 68.
Launch "Aehcron," Australia . . . . * "*Engineering*," xxviii. 52, 99.
Danube . . . . . "*Iron Age*," xx., July 26, p. 18.
Herreshoff, Br. . . . * "*Engineering*," xxvii. 93.
Thorneycroft . . . * "*Engineering*," xxiii. 449.
And generator, *Herreshoff* . . . . . * "*Scientific American*," xl. 210.
On . . . . . * "*Engineering*," xxii. 383.
"*Engineering*" . . . "*Van Nostr.'s Mag.*," xvii. 125.
Nettiugs, "Thuuderer" * "*Scientific Amer.*," xxxvii. 3, 5.
Ram, Br. . . . . "*Iron Age*," xix., April 19, p. 24.
Ship "Alarm," U. S. . * "*Engineering*," xxiii. 283.
"Zieten," Ger. . . . "*Engineering*," xxi. 211.
Station, U. S., work at . "*Scientific American*," xl. 71.
Torsion of shafts, testing apparatus, Br. . . * "*Engineering*," xli. 336.

Fig. 2446.



Torsion Forceps.

Tor'sion For'ceps. (*Surgical.*) An instrument (see Fig. 2446) for twisting the end of an artery as a substitute for ligation.

Shown at Figs. 98*b*, 100, 102*b*, 163, Part I., *Tiemann's* "*Armamentarium Chirurgicum.*"

Tor'ti-col-lis Brace. A brace for overcoming distortions of the neck.

Tough'ened Glass. La Bastie's toughening process consists in heating the glass, nearly to malleability, but not hot enough to lose its shape, say 1400°, and plunging it instantly, in this state, into a bath of fatty and resinous matter at a temperature of from 300° to 600°. This glass will withstand sudden changes of temperature without damage, as the pouring of molten lead into a tumbler. The strength of the glass is said to be increased many times. Lamp chimneys and other articles thus made are very durable. See GLASS, TEMPERED, *supra.*

In the Siemens' glass works at Dresden there is now manufactured a product which has the same properties as La Bastie's tempered glass, the strength being communicated by the pressure of metallic rolls. Plates can be made by this method of much larger dimensions than by La Bastie's. They have a beautiful look, and can be ornamented with the most complicated designs, at a less cost than ordinary glass. When broken, it shows a fibrous structure, while La Bastie's is crystalline. For equal thickness the resistance of a plate of compressed glass is from seven to ten times as great as that of an ordinary plate.

Tour'ists' Pho-to-graph'ic Cab'i-net. An apparatus is made which works without a silver bath, the silver nitrate having been already united to the haloid salts in the collodion, and a *washed emulsion* is supplied in a bottle.

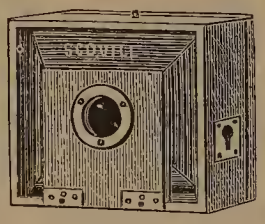
The bottle being shaken and allowed to stand 10 minutes, the emulsion is poured on the glass plate. The glass is previously washed by tripoli in alcohol, followed by French chalk. In 2 minutes the film is set and may be exposed in the camera; or if kept in reserve, dried over a hot tin or spontaneously, in 20 minutes. Non-actinic light, of course, is used in these operations, a portable ruby glass lantern being furnished.

After exposure the film is washed and picture developed by a mixture of pyrogallic acid and ammonia, restrained in action by a suitable quantity of potassium bromide. It is then washed, fixed, and washed again.

The film can be removed to a piece of prepared paper, and when dry can be put in a book, and reimposed at any time for printing. A set of 6 glass plates is furnishing enough, and a blank book may contain the films of a prolonged tour.

Tour'ists' Pock'et Cam'e-ra. Fig. 2447 is the pocket camera of the Scovill Manufacturing Co. of New York, intended for tourists' use. It measures, when folded up, but $5\frac{3}{4}'' \times 6\frac{1}{2}'' \times 2''$, with no projecting parts.

Fig. 2447.

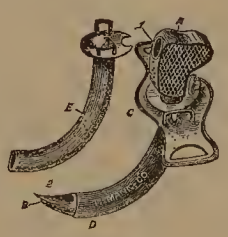


Tourist's Pocket Camera.

Tow'er, Re-volv'-ing. Theodore R. Timby, of Worcester, Mass., in 1841, filed a model and caveat in the U. S. Patent office for a revolving tower or fort, to be revolved by engines within the same; for use on land or water. He was granted a patent in 1862. A tank having been formed at the desired location, with the addition of water supply and exit pipes, the first communicating with a supply tank, and the latter with a drain, the water supply is regulated as desired through these pipes. A metallic battery is floated in this tank, revolving round a central pillar, on which it is lifted or lowered by the adjustment of the water supply in which it floats. Openings in the embankment that surrounds the tank and tower give the necessary opportunity for the exercise of the guns or mortars.

Tra'che-o-tome. Hauk's instrument, Fig. 2448, is to obviate the danger from blood entering the trachea during an operation.

Fig. 2448.



Tracheotome.

It consists of a curved, hollow, sharp-pointed trocar, with handle (also hollow) attached, — the whole about $3\frac{1}{2}''$ in length. It is made to exactly fit the larger of the set of tracheotomy tubes.

Tra'cing Cop'y-ing. A photographic process called the blue process, in which a tracing is used to print from instead of the glass negative.

For the sensitizing solution take $1\frac{7}{8}$ oz. citrate of iron and ammonia, and 8 oz. clean water; and also $1\frac{1}{4}$ oz. red prussiate of potash, and 8 oz. clean water; dissolve these separately, and mix them, keeping the solution in a yellow glass bottle or carefully protected from the light.

The paper may be gone over once with the sponge quite moist with the solution, and the second time with the sponge squeezed very dry. The sheet should then be laid away to dry in a dark place, as in a drawer, and must be shielded from the light until it is to be used. When dry the paper is of a full yellow or bronze color; after the exposure to the light the surface becomes a darker bronze, and the lines of the tracing appear as still darker on the surface. Upon washing the paper the characteristic blue tint appears, with the lines of the tracing in vivid contrast.

Any good, hard paper may be employed (from a leaf from a press copy-book up to Bristol board) which will bear the necessary wetting.

Lay the paper, sensitized side up, on a smooth blanket, and place the tracing on this with a plate of clear glass over all, heavy enough to press the tracing close down to the paper.

Expose the whole to a clear sunlight for six to ten minutes. If a clear skylight only can be had, the exposure must be continued for thirty or forty-five minutes, and under a cloudy sky, sixty to ninety minutes may be needed.

Remove the prepared paper and drench it freely for one or two minutes in clean water, and hang it to dry.

Track In'di-ca'tor. (*Railway.*) An instrument devised to ascertain the condition of the track, indicating irregularities, low joints, etc. One used on the Pennsylvania Railway is designed by R. Pitcairn, locomotive superintendent of the Pittsburg Division.

It is described and illustrated in "*Engineering*," * xxv. 119, 122. See also Dynagraph.

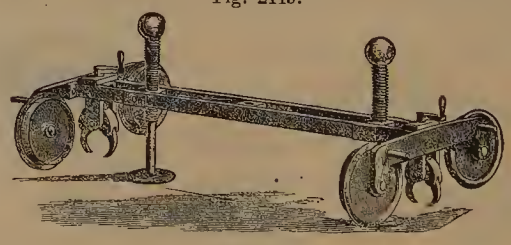
Track'-lay-ing Ma-chine'. A construction machine carrying rails and ties, with devices for delivering them off the front of the train to the laying force. The train is advanced as the work progresses.

It consists in a succession of rollers set in movable frames attached at will to the sides of several flat cars in a train, elevated so as to afford an inclined plane from rear to front. Upon these the ties on one side and the rails on the other are easily rolled or laid by men upon the cars, when they move along over the rollers to the front, and are delivered to the tie and track layers as fast as they can use them.

Track Lift'er. For lifting railroad tracks in ballasting and leveling.

A truck frame with four ordinary flanged wheels running on the rails, has a strong central cross-bar, bearing a spirit-level

Fig. 2449.



Track Lifter.

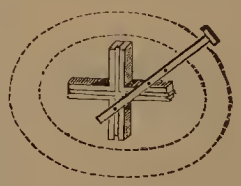
and scale, by which any degree of inclination is indicated. Through this central bar two powerful screws play in suitable swiveled nuts, and have each a pivoted base plate to thrust against the ground, and a suitable lever at the top.

Trac'tion En'gine. A form of locomotive engine adapted to travel on ordinary roads. Used to haul threshing machines, and other heavy objects from point to point, and in threshing and furnishing power for different purposes.

Fig. 2451 represents Owen, Lane, & Dyer's engine, geared and speeded for $2\frac{1}{2}$ to 4 miles an hour; will draw a 10- or 12-horse power thrasher with ease; runs in either direction; carries fuel and water for 4 hours' run; will pull up or down a grade of 1 in 12.

See "*Mech. Dict.*," p. 2608.

Fig. 2450.

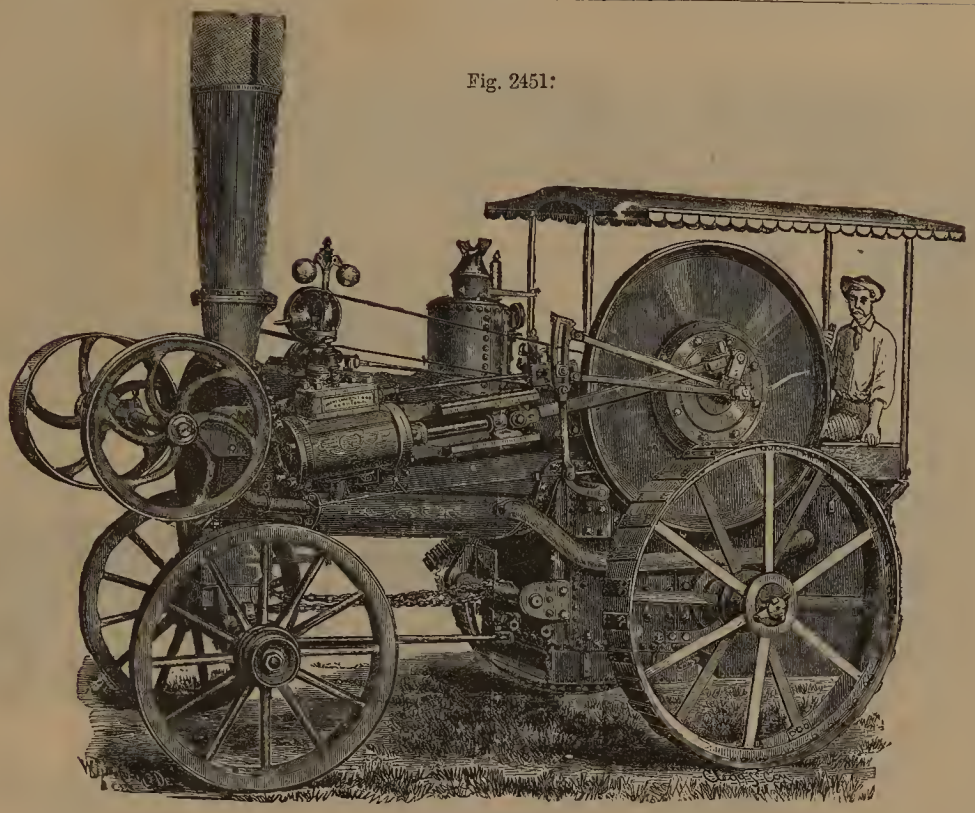


Tram.

Tram. A device for describing an ellipse.

When oval moldings are required two pins are placed in two holes of the handle to the center-mold, and made to move in the rectangular grooves of the cross represented in

Fig. 2451.



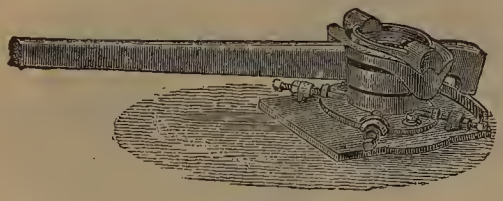
Traction Engine

the lower central figure, which illustrates one of the practical ways to describe an ellipse, and the best way in which a plasterer can make an oval molding. See Fig. 2450.

Tram'pot. (*Milling.*) The seat in which the foot of the spindle is stepped.

Fig. 2452 shows an improved adjustable center-lift trampot, with the lever arm swiveled to turn in any direction out of the way of spouting or other objects.

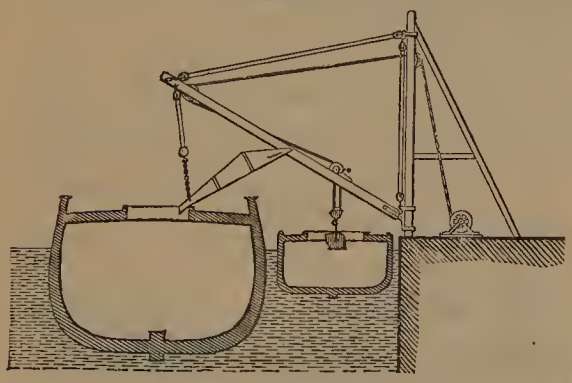
Fig. 2452.



Trampot.

Trans'fer El'e-va-tor. An elevator or crane for hoisting from one vessel into another. See Fig. 2453.

Fig. 2453.



Transfer Elevator.

Trans-la'tor. 1. (*Generally.*) An instrument whereby one form of energy is converted into another. For instance: the *power* of a prime motor, say a steam engine, is *translated* by means of a magneto-electric engine into electricity.

2. (*Specifically.*) A British term for a *repeater.*

Trans-mit'ter. (*Electricity.*) 1. In former practice, the sending forward of a message by an operator at a receiving station was called *transmitting.*

This function is now performed in telegraphy by a *repeater*, sometimes called in Britain a *translator.*

2. The sending instrument in telephonic circuit.

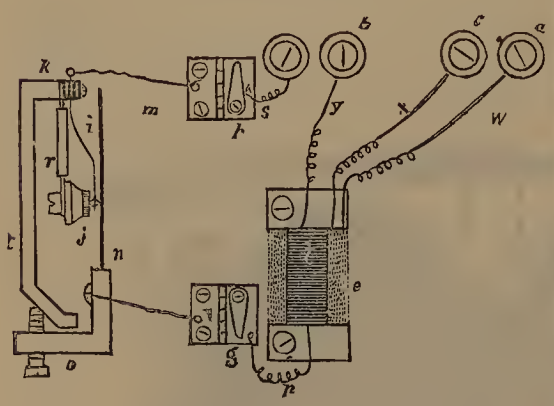
(*a.*) In Bell's *transmitter* (see Fig. 2402, Plate XLVIII.) the message is sent by the variable induced currents set up in a coil surrounding a permanent magnet, to and from which the diaphragm plays.

(*b.*) In the Edison carbon transmitter the diaphragm impinges upon a carbon button through which a battery current is led to line. The vibrations of the diaphragm and the consequent varying pressure upon the carbon affect the conductivity of the latter, and consequently give rise to undulations in the current, corresponding in amplitude and force to the sound vibrations of the spoken message.

(*c.*) In the Blake transmitter, Fig. 2454, a battery current is led through the primary helix of an induction coil, the secondary coil of which is included in the line circuit.

The battery wire comes to the binding post *b*. The circuit goes to primary coil *f*, composed of a few layers of coarse wire, thence by curl *p* to hinge *g*, thence by wire *l* to back frame *v*, thence through screw *o* and adjusting bar *t* to spring *r*, on the end of which is a weighted carbon button, *j*, thence through carbon button and platinum bead to spring *i*, which is insulated at *k*, thence by wire *m* to the hinge *h*, thence by curl *s* to binding post *a*, thence to battery, thus forming a short local circuit, including a battery, a primary coil, and a delicate carbon and platinum contact. The insulated diaphragm *n* bears against the platinum bead, and any movement of the diaphragm, by the voice or otherwise, alters the degree of pressure between the platinum bead and carbon button. Any alteration of pressure alters the conductivity at this point, and thus varies the intensity of the current which the battery is sending through the primary coil *f*. Under the jarring effect of the voice the contact at *j* is constantly altering, and thus giving a series of impulses to the current passing through the primary coil.

Fig. 2454.



Blake Transmitter.

This battery circle is entirely local, and does not go to line.

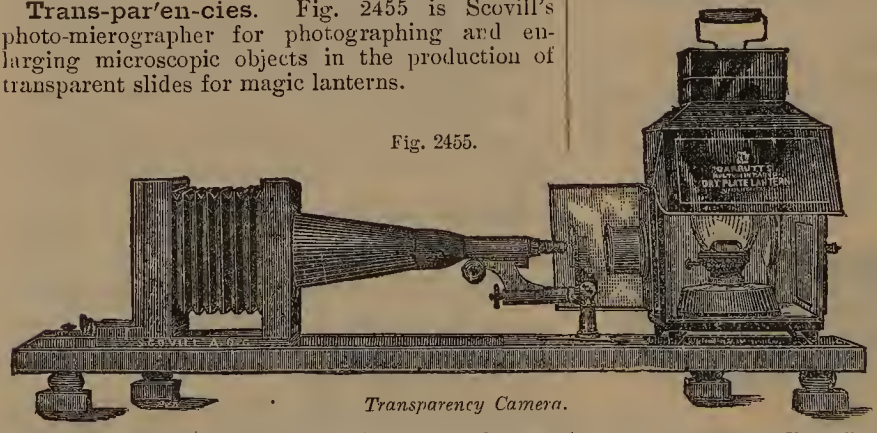
The line wire with telephone and other apparatus in circuit, goes to binding post *d*, thence by curl to secondary coil *e*, composed of many layers of fine wire wound outside of the primary coil *f*, thence by curl to binding post *c*, thence to ground or continued line.

The telephone or line circuit contains, as far as the transmitter is concerned, only the secondary coil. When a current passes through the primary coil wire it induces a strong current in the secondary coil wire, and thus sends the impulse to the line.

Telephonic, *Redmond* . * "*Engineer*," xxvi. 184.
* "*English Mechanic*," xxvii. 653.
Blake . . . . . * "*Scientific American*," xli. 274.
"*Scientific American Sup.*," 3989.
Hopkins . . . . . * "*Scientific American*," xlii. 292.
Duplex and quadruplex "*Iron Age*," xxv., March 4, p. 19.

Trans-par'en-cies. Fig. 2455 is Scovill's photo-mierographer for photographing and enlarging microscopic objects in the production of transparent slides for magic lanterns.

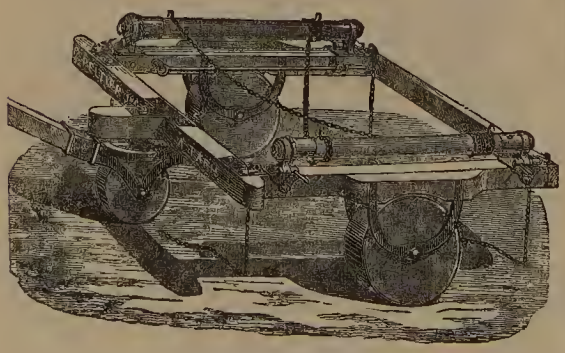
Fig. 2455.



Transparency Camera.

Photographing with the microscope has hitherto beeu accomplished by the aid of elaborate and costly apparatus. and been applied chiefly to making illustrations for scientific magazines. The process used, that of wet collodion in connection with sunlight, involved the procurement of an expensive heliostat to produce a steady illumination, for with any less powerful light the exposure would necessarily be so prolonged that the coating of the plate would dry and become useless. Now all this is changed, for with the modern improvements in photography which are the result of the introduction of gelatine dry plates, the photographing of microscopic objects becomes easy of accomplishment.

Fig. 2456.



Transplanting Wagon.

Trans-plant'ing Wag'on. Fig. 2456 shows a three-wheeled truck, the frame of which uncouples and surrounds the tree. The chains are crossed under the roots and the tree hoisted out of its hole by means of levers in the holes in the rollers, and transported to the place of planting, where the truck straddles the hole, and the tree is let down.

Trap. A sink or depression in a pipe which allows the liquid contents to fill it permanently at one point and prevent passage of air.

Fig. 2457.

Traps.

a. P-trap.
b. P-trap, with flange for hopper.
c. S-trap.
d. Flanged S-trap.
e. Running or belly trap.
f. Same with hand-hole.
g. Conductor trap.
h. Bell trap.
i. Yard trap.
j. Round bottom drain trap.
k. Stable trap.

Trav'el-ing Crane. A derrick on an elevated track for shifting to different parts of the building. In Fig. 2458 the winch is operated by bevel gearing from the shafts at the side of the building. The transverse shafts have an endwise movement to disengage them from the gearing on the shaft along the side of the room, in shifting the carriage lengthwise of the room.

Trav'ers-ing Saw'ing En'gine. Fig. 2459 shows the Brotherhood three cylinder traversing metal-sawing engine. The whole machine traverses longitudinally in cutting the material to be operated on. The power is obtained from a hydraulic cylinder, and the speed of traverse is regulated by a slide valve. Steam may be used.

Trav'ers-ing Saw'ing Ma-chine'. One in which the saw travels instead of the work operated on.

Saws for cutting cold steel are made of soft iron, and run sometimes with a periphery speed of nearly five miles a minute, melting the steel sparks, but not withdrawing the temper from the piece.

Tray Bat'te-ry. (*Electricity.*) One in which the tray forms one of the elements of the combination.

See THOMSON'S BATTERY, in which the tray is of copper.

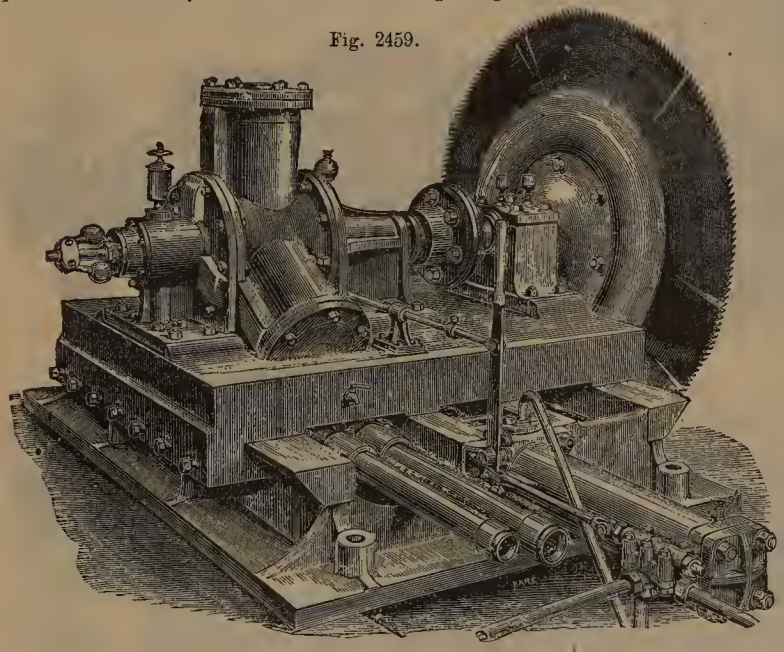
Tree-fel'ling En'gine. An application of steam for felling trees.

Fig. 2458.

Traveling Crane.

The illustration, Fig. 2460, shows a small steam cylinder, with comparatively long stroke, mounted on a light wrought-iron frame, pivoted on its center; a movement around this pivot is controlled by a worm-wheel and screw gearing into a

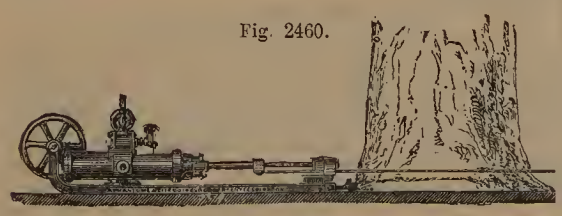
Fig. 2459.



Traversing Sawing Machine.

circular rack. A saw is rigidly fixed to the cross-head, the teeth of the saw arranged to cut only during its in-stroke; that is, the teeth are hooked on one side and have a long bevel on the opposite one; the saw makes a draw-cut during its passage toward the cylinder, which enables a brace between the cylinder-frame and the tree to resist in compression alone the force of the cut. The steam distribution is effected directly from the cross-head, and so arranged as to take full steam for the in or cutting stroke of the saw, and but one tenth the amount for the return or idle stroke.

Fig. 2460.



Tree-felling Machine.

Trem'bler. (*Electricity.*) A contact breaker for induction coils.

The improvement of M. Trouvé is designed to secure various rates of vibration of the *trembler*, so as to obtain intermittent induction currents of different periods. The length of the vibrating stem is made adjustable, and its range limited according to a scale on the instrument.

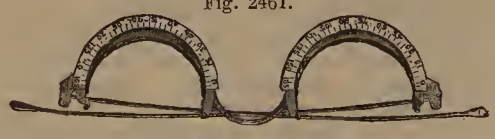
"*Teleg. Journal*" . . . v. 280.

Trial Sight. (*Optical.*) An oculist's case of trial lenses, etc., for testing sight. Nachet's complete series has the following:—

32 pairs each of spherical convex and concave lenses, from 2″ to 72″ focus.
19 pairs each of plain cylindrical convex and concave lenses, from 6″ to 60″ focus.
9 prisms of angles, from 2° to 10°.
4 plane colored glasses.
1 white glass disk.
1 half ground surface.
2 metallic disks with stenopaic slit.
1 metallic disk with hole.
1 metallic disk, solid.
1 adjustable spectacle-frame, with revolving graduated fittings for holding the various lenses.
1 ditto, not graduated.

Trial Spec'ta-cle Frame. Fig. 2461 shows a trial spectacle frame, with double grooves to

Fig. 2461.

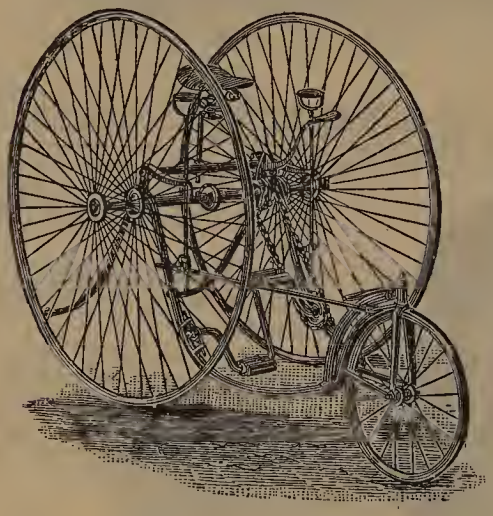


Trial Spectacle Frame.

each eye, graduated to 180°. Any desired combination of spherical and cylindrical lenses can be adjusted in a moment to this frame, and given to the patient for trial. Used for finding the axis of imperfect vision in astigmatism or cylindrical cornea.

Tri'cy-cle. The name was given to a specialized, three-wheeled velocipede in France, as long ago as 1828. It has been made in variously modified forms ever since that time, but has gone into extensive use only in recent years, after the more successful bicycle had led the way, and improved materials and means and modes of construction had enabled it to be made lighter and more effective and elegant. It is now very popular in England and throughout Europe, where it is ridden by ladies as well as by gentlemen, not only for occasional pleasure riding and useful conveyance, but also on very long tours through the various countries. It is rapidly coming into use in America, and the latest and most improved form is the Columbia tricycle, of American make, shown in Fig. 2462. The wheels are 48″ in diameter, the width over all is 38″, and the weight 92 pounds. It has

Fig. 2462.

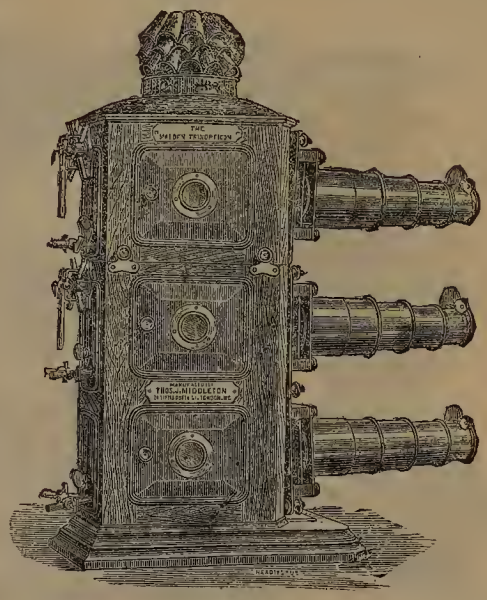


The Columbia Tricycle.

contractile round rubber tires, direct spokes in the suspension wheels, adjustable anti-friction bearings to every shaft, axle, pin, and pedal, and adjustable seat and handles to suit it to the individual rider. Ingenious mechanism is shown in the "balance gear," or compensating axle gearing, by which the power is distributed to both driving wheels, which may run at differing speeds on curves; and also in the friction-disk brake, which with a slight pull on the handle will effectively control the machine on any grade. This tricycle contains fifteen or more inventions secured by United States patents. There is also adapted to it a device by which different speeds may be attained with the same power, or power economized at the expense of speed in hill-climbing; and there are many useful adjuncts called "accessories" for the convenience of riders. The tricycle is brought to such a state of perfection and specialized detail in construction and finish as to be only comparable with the bicycle.

Trin-op'ti-con. The "Malden" trinopticon, Fig. 2463, is an apparatus for the exhibition of dissolving views and dioramic effects. It consists of a combination of three achromatic lanterns, which can be used in its complete form; or the bottom portion, that is similar to an ordinary two-tubed

Fig. 2463.

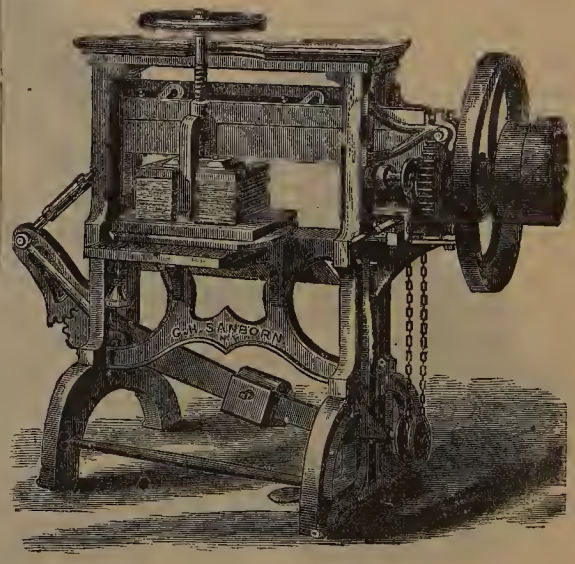


Trinopticon.

apparatus, can be used separately, and the upper can then be employed for phantasmagoric effects.

Trim'mer. (*Bookbinding.*) The Star book trimmer, Fig. 2464, is a single, or double clamp power machine, with a draw-slide knife.

Fig. 2464.



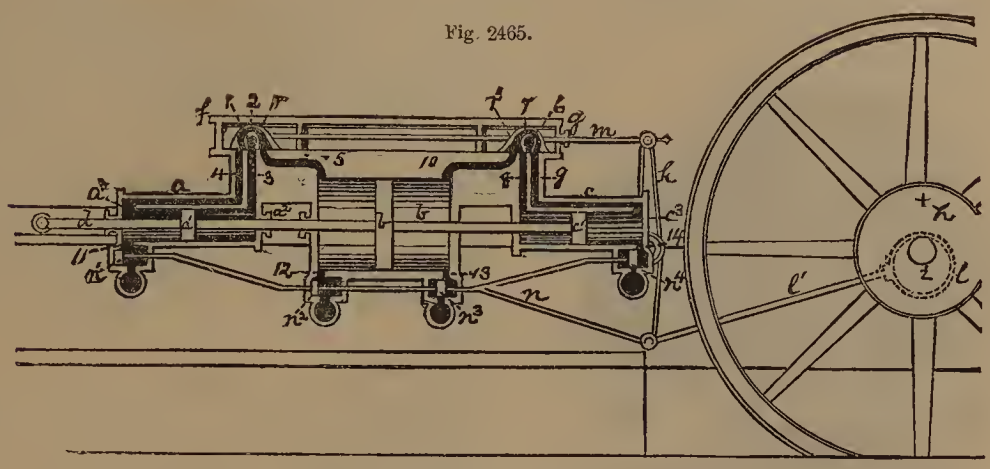
Book Trimmer.

Trip Cut Off. An arrangement to disconnect one portion of the valve motion from the other, so as to allow the cut-off valve to close with great rapidity, the concussive effect arising from stopping the rapidly moving parts being absorbed or taken up by acting upon a confined indestructible fluid, as water, air, etc.

Trip'le Cyl'in-der Steam En'gine.

Alexander's compound balanced piston engine, Fig. 2465, has a large central vacuum or exhaust cylinder, *b*, at each end of which is a smaller working cylinder, *a c*; the pistons of the three have a common piston rod and their valves are operated by the rods *d c* from the eccentric *f*, being so arranged that a part of the exhaust from either working cylinder, as *a*, is conducted into the corresponding end of the exhaust cylinder *b*, alternately through the passages *g g'* at the same moment that the steam is admitted to the opposite end of the other working cylinder; the pressure of the exhaust

Fig. 2465.



Triple Cylinder Steam Engine.

steam from *a* on either side of the piston *b'* is thus caused to help work the pistons *a' c'*. The steam escaping from *a* or *c* is worked expansively in *b*, being reduced to a pressure equal to that of the atmosphere by the time *b'* reaches the end of its stroke.

The remaining portion of the exhaust is conducted through an appropriate post to the end of either working cylinder at which the piston of that cylinder has arrived, to balance the piston so that it may offer no resistance to the action of the large piston in the exhaust cylinder, and to that of the other working cylinder to which the live steam has just been admitted.

Trip'le Flu'id Bat'te-ry. (*Electricity.*) One in which the respective fluids containing the elements are separated by a cell containing another fluid which may be neutral or may have the effect of preventing the entry of the positive liquid into the negative cell, or *vice versa*. For instances, see list under GALVANIC BATTERY.

Trip'le Tel'e-phone. One having two receiving ear-pieces, and a transmitting mouth-piece mounted on one stem, which may be held to the head by a spring.

Pritchett . . . . . * "*Telegraphic Journal*," vi. 471.

Trip'o-li. Infusorial earth: the cast-off shells of microscopic infusoria. Used in the manufacture of nitro-glycerine, cements, as polishing powders, and food.

Tro'car. (*Surgical.*) A perforator, stylet, and canula combined; a three-part instrument.

Trough Bat'te-ry. (*Electricity.*) One in which the elements occupy a series of cells in a common trough.

The earliest of these was Cruikshank's, and the second Wollaston's, which see. See also MUIRHEAD BATTERY.

Trou-vé' Bat'te-ry. (*Electricity.*) 1. A battery consisting of a pile of zinc and copper disks separated by paper disks, saturated with exciting and depolarizing liquids.

See MOIST BATTERY.

Niaudet, American translation . . . * 112.
"*Scientific American*" . . . . . * xxxvii. 323.

2. A compound Grenet battery, in which several pairs of removable elements are mounted on a frame which can be lowered into the liquid.

Niaudet, American translation . . . . . * 224.

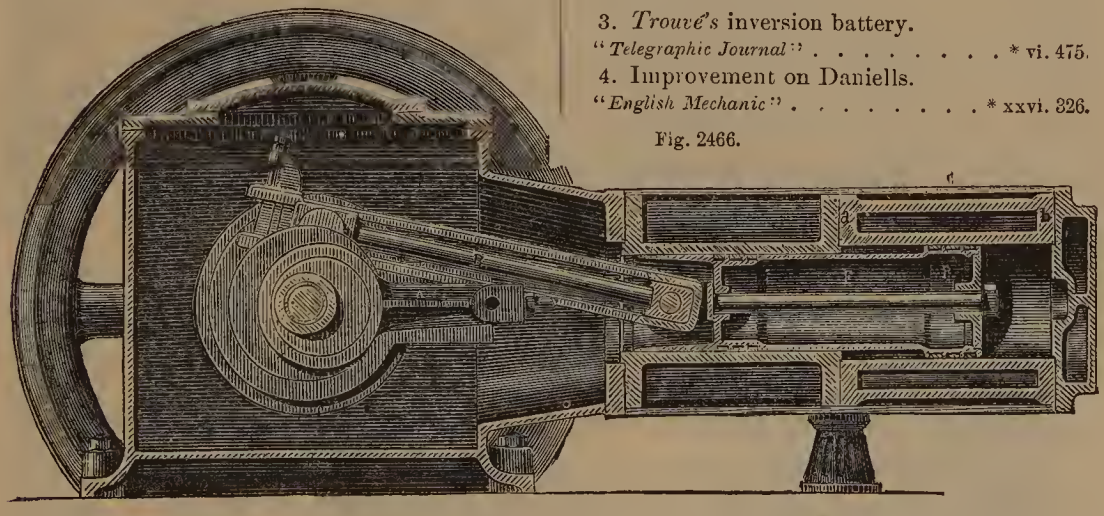
3. *Trouvé's* inversion battery.

"*Telegraphic Journal*" . . . . . * vi. 475.

4. Improvement on Daniells.

"*English Mechanic*" . . . . . * xxvi. 326.

Fig. 2466.



Trunk Engine.

Trunk Steam En'gine. One in which the direct connection of the piston with the crank is secured without the use of the beam or oscillating the cylinder. Fig. 2466 shows Virey's French trunk engine, with the piston rod, crank shaft, and eccentric in the steam chest, attached to the steam cylinder, the revolving shaft working through packings in the steam chest.

Truss'ing Ma-chine'. One for tightening the truss hoops on barrels. Holmes's machine, Fig. 2467, for trussing tight and slack barrels, will drive all the truss hoops upon a slack barrel at the same time at the rate of 1,500 per day. When used for tight barrels the quarter hoop drivers are removed, and the machine is in condition to drive the truss hoops upon tight barrels.

Fig. 2467.

Trussing Machine.

Tube Clean'ers. For cleaning tubular boiler tubes. A steam-pipe having perforations to correspond with the ends of the tubes is fitted to each row of tubes and steam blown through them.

Tube cleaner . . . . * "*Scientific American*," xxxiv. 248.
"National" . . . . * "*Iron Age*," xvii., March 30, p. 7.
Boiler, *Cooke* . . . * "*Iron Age*," xxiv., Sept. 11, p. 16.
Tube-cleaning rings. *Paulson*, Br.
* "*Railroad Gazette*," xxiv. 205.
* "*Engineer*," xlix. 235.
Tube scraper, *Knott* . . * "*Engineer*," xlii. 33.
Rastrick, Br. . . . . * "*Engineer*," xliv. 149.
Boiler, *E. Ry. of France* * "*Engineering*," xxix. 7.

Tube Draw'ing Ma-chines'. Metallic tubes are drawn through formers, somewhat after the manner of wire.

Tubes for particular purposes are drawn inside and out, giving them a hard, smooth finish. Ordinary brass tubes are soldered together and drawn through holes to shape the outside, leaving the inside as it was.

Fore . . . . . * "*Iron Age*," xxii., July 11, p. 1.

Tube Valve. A tube forming a valve, held up against its seat by a ball-weighted lever.

Tube, Weld'ed I'ron. Instead of heating the whole of the strip or skelp of iron, Roden heats only the edges which are to be welded together and the parts adjacent thereto. In order to effect this, he constructs a furnace, having a long, narrow opening at its top, and the strip of iron from which the tube is to be made having been bent into a tubular form, with its edges overlapping, is placed upon the said opening in the furnace, the said overlapping parts being alone exposed to the strongest heat of the furnace, while the greater part of the tube, being external to the furnace, is but slightly heated. Near the end of the furnace a bulb mandril, supported on a rod, is situated, the axis of the said bulb mandril being in a line with the axis of the partially formed tube on on the furnace.

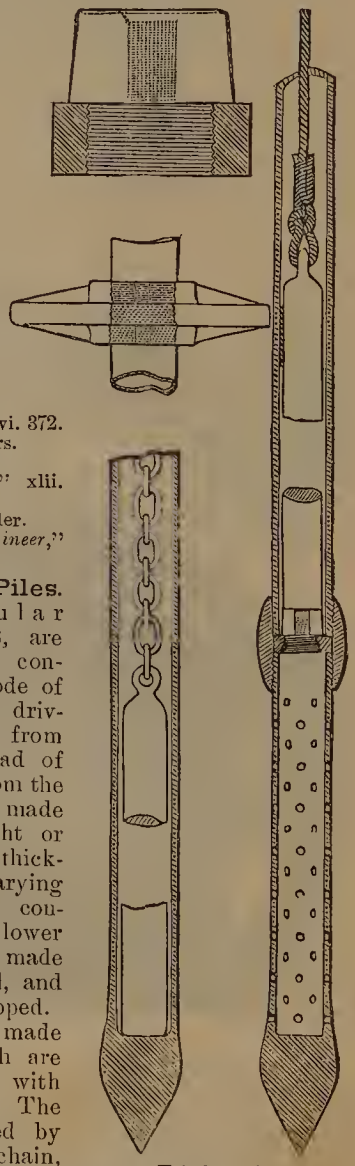
The end of the mandril-rod is fixed to a wagon, capable of traveling on a draw bench. Underneath the bulb of the mandril is a pressing-roller, which is pressed upwards or against the bulb of the mandril by a spring or weight or otherwise. A pair of tongs, connected to the wagon of the draw bench or other drawing mechanism, take hold of the partially formed tube at its upper side, and motion being communicated to the said chain, draw bench, or other drawing mechanism, the partially formed tube is drawn off from the furnace on to and over the bulb mandril, its overlapping and heated edges being pressed between the bulb of the mandril and the roller underneath and thereby welded together. After the welding of the skelp has been effected, the mandril and its rod, together with the tongs and welded tube, are removed to a sufficient distance from the furnace to allow the tube to be removed from the mandril. The mandril and other parts are then restored to their original positions near the furnace, ready to act upon and weld a second skelp. By means of this invention, welded iron tubes or pipes can be readily and quickly made, and from thinner iron than can be conveniently used in the ordinary method of manufacture.

Weldless metallic . . "*Iron Age*," xvii., May 11, p. 32.
Welded iron, manuf. of "*Scientific American Sup.*," 1886.

Tu'bu-lar Boil'er. One in which the water circulates in pipes. See STEAM BOILERS, *supra*, and pp. 2325–2328 and 2649, "*Mech. Dict.*"

Babcock & Wilcox . . * "*Iron Age*," xix., May 31, p. 1.
Benoit, Fr. . . . . * "*Engineer*," xlv. 354.
Pregardieu, Ger
* "*Engineer*," l. 228.
Sinclair, Belg.
* "*Engineer*," xlvii. 42.
Steinmüller, Ger.
* "*Engineer*," xlix. 428.
Wigzell & Ramsden.
* "*Engineer*," xli. 313.
"Montana" "Birkenhead."
* "*Engineer*," xli. 316.
Mast,
* "*Manuf. & Builder*," viii. 246.
Tubular flue boiler.
Sulzer, Swiss.
* "*Engineering*," xxviii. 175.
Farcot, Fr.
* "*Engineering*," xxvi. 372.
Tubular steam boilers.
Babcock & Wilcox.
* "*Scientific Amer.*," xlii. 319.
Tubular vertical boiler.
Pope, Br. * "*Engineer*," xliii. 251.

Fig. 2468.



Tubular Piles.

Tu'bu-lar Piles. Le Grand's tubular piles, Fig. 2468, are unique in their construction and mode of propulsion, being driven internally and from the bottom, instead of externally and from the top. The piles are made of either wrought or cast-iron, and of thickness to suit the varying circumstances of construction. The lower end of the pile is made solid and pointed, and generally steel-tapped.

The piles are made in sections, which are screwed together with joint sockets. The rammer is raised by rods, rope, or chain, and on being released, falling with its own gravity, expends its driving force on the point just where it is wanted.

This principle of internal pile-driving has been

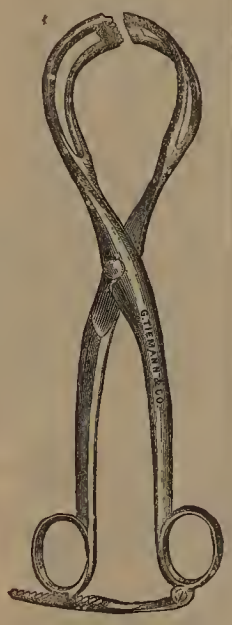
applied to the sinking of tube-wells, and for driving the foundations of telegraph posts, etc. When used in connection with tube wells, the first socket above the perforated end is made sufficiently long to allow of a strong iron ring being placed in the center of it in such a way that the two lengths of tube, when screwed together, butt against it. The interior of this ring is of sufficient size to allow the water to pass freely, but it has a screw thread cut throughout its whole length. During the operation of driving the aperture is closed by a steel square-headed screw plug, the head resting firmly on the ring. After driving, the plug is removed, allowing the water free passage.

LeGrand & Sutcliffe . "*Van Nostrand's Mag.*," xx. 521.

Tu'la. The Russian niello silver. See NIELLO SILVER.

Tu'la Sil'ver. The composition tula silver, which was long kept a secret, has been discovered to consist of 9 parts of silver, 1 of lead, and 1 of bismuth. The metals, in the proportions stated, are melted together. The addition of sulphur gives the beautiful steel-blue tint for which this composition is so highly prized.

Fig. 2469.



Tumor Ecraseur.

Tu'mor E-cra'seur. Fig. 2469 represents an instrument used in operating on uterine tumors.

Tung'sten Bronze. A bronze produced by Majeon by adding tungsten to a composition of copper, zinc, lead, and tin; a bronze of small cost, possessing, according to the proportions of the elements, malleability, ductility, sonorousness, and conductivity of electricity.

Used for dies, bells, clockwork, ornaments, type, piano strings, brass for rolling, drawing, and chasing.

"*Iron Age*," xx. Sept. 6, p. 20.

Tung'sten Steel. (*Metallurgy.*) A steel containing tungsten, which is added in the form of Wolframite to the charge. See p. 2366, "*Mech. Dict.*"

Tungsten steel . . . "*Scientific American Sup.*," 278.

Tun'nel. (*Fishing.*) The funnel-shaped conductor leading from the *heart* to the pound in a *pound-net*, which see.

(*Engineering.*) An underground passageway for aqueducts, railways, or opening up mines, etc. See "*Mech. Dict.*," pp. 2653–2655.

Tunneler, *Dowd* . . . "*Scientific American*," xliii. 280.
Tunneling, accurate . . "*Scientific American*," xxxix. 406.
Tunneling machine.
Dowd . . . . . * "*Manuf. & Builder*," xii. 244.
Tunneling, history of, *Drinker*. Wiley & Snow, N. Y. See excerpts in "*Engineering & Mining Journal*," xxv.

Tu'pe-lo Di-la'tor. (*Surgical.*) A dilator for the cervix uteri, made from the wood of the pepperidge (sour grass, *Gray*), a tree of the dogwood family and genus *Nyssa* (Indian name *tupelo.*) — *Sussdorff.*

Tur'bine. A water wheel with curved buckets. See p. 2656, "*Mech. Dict.*"

Turbine water wheels.
Trials of, Phila. 1876 * "*Scientific American Sup.*," 964.
Turbine wheels, on.
Gevelin . . . . . "*American Miller*," v. 11.
Turbine, *Alcott* . . . * "*Iron Age*," xx., Oct. 18, p. 1.
* "*Manuf. and Builder*," viii. 247.
* "*American Miller*," vii. 166.
Burnham . . . . . * "*American Miller*," iv. 33.
"Eclipse," *Stillwell & Bierce* . . . . . * "*American Miller*," iv. 33.
Dorsey & Kemper . . * "*American Miller*," iv. 35.
"Delphos" . . . . * "*American Miller*," iv. 35.
Leffel . . . . . * "*American Miller*," iv. 36.
* "*Manuf. & Builder*," ii. 198, 225.
* "*Engineer*," xliii. 59.
Obenchain . . . . * "*American Miller*," iv. 38.
Carley . . . . . * "*American Miller*," v. 101.
Mullikin . . . . . * "*American Miller*," v. 101.
Capron . . . . . * "*American Miller*," iv. 2.
Brooks . . . . . * "*American Miller*," v. 83.
Risdon . . . . . * "*American Miller*," v. 121.
* "*Manuf. and Builder*," ix. 56.
"Little Giant," *Jones* * "*American Miller*," vi. 152.
Tompkins . . . . * "*American Man.*," July 9, 1880, p. 13.
Ou. *Trowbridge* . . * "*Van Nostr. Mag.*," xx. 244, 346.
"Victor," *Stillwell & Bierce* . . . . . * "*Eng. & Min. Jour.*," xxviii. 145.
* "*American Miller*," vii. 163.
Whitmore . . . . . * "*American Miller*," iii. 179.
"Victor," *Holden* . . * "*Scientific American*," xl. 166.
"Canadian" . . . . * "*Iron Age*," xxii., Dec. 12, p. 5.
Truax . . . . . * "*American Miller*," viii. 68.
Ridgeway . . . . * "*American Miller*," viii. 32.
Bollinger . . . . . * "*American Miller*," viii. 64.
Todd . . . . . * "*American Miller*," viii. 225.
Walton . . . . . * "*Scientific American*," xxxiv. 374.
Jouval. Augsburg Water Works . . . . * "*Engineering*," xxix. 244.
Test of. Phila., 1876 "*Scientific American Sup.*," 927.
Centennial, "Allentown," *Thompson* . "*Iron Age*," xviii. Aug. 31, p. 7.
Centennial. *Boyden, Bollinger*, "National," *Hunt, Houston Leffel*, "American," "Eclipse," "Eureka," *Cope* . . . . "*Iron Age*," xviii., July 20, p 3.
Alcott, Risdon, Gayelins', Jouval . . . "*Iron Age*," xviii., Aug. 3, p. 3.
66″. Gunpowder factory, Watham, Br . * "*Engineer*," xlii. 379.
And pumps, *Buxton*, Br. . . . . * "*Engineering*," xxx. 546.
Tests, Holyoke . . . "*Scientific American*," xli. 336.

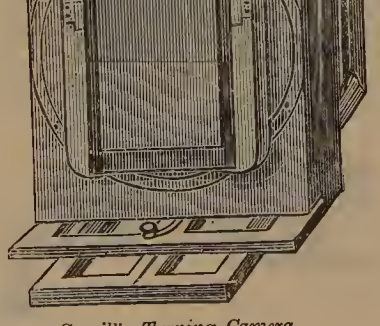
Tu-renne' Cloth. (*Fabric.*) A cotton and wool French goods.

Tur'mer-ic Pa'per. (*Gas.*) Used as a test for the presence of ammonia in illuminating gas.

Add 6 parts by weight of alcohol to 1 of turmeric powder in a stoppered bottle, and shake occasionally for 3 days. Soak white filtering paper in the solution, dry, cut in convenient pieces, and keep in a stoppered bottle.

Turn'ing Back Cam'e-ra. One to enable the view taker to secure either an upright or a horizontal picture without changing the plate holder,

Fig. 2470.



Scovill's Turning Camera.

after it has been slid into the carriage. The carriage is simply turned about in the circle and automatically fastened. By this latter provision the carriage may be secured at either quarter of the circle. The ability to withdraw the slide to the left enables the photographer to obtain a view which he could not get with the usual provision in a camera. The photographer of experience is well aware of the difficulty, when taking an upright picture with a large camera, of reaching up to draw out the slide at the top, and, what is more essential, of getting out the slide without changing the plate in the holder.

Turn'ing Mill. See BORING AND TURNING MILL, Fig. 389, p. 122, *supra*, and Fig. 6799, p. 2660, "*Mech. Dict.*"

Turn'ing Mold'-board Plow. One which has a capacity by an optional adjustment of the mold-board and share for turning a furrow to the right or to the left respectively.

In this country it is usually called a side-hill plow, as it is used only on hill-sides for throwing a furrow constantly down hill at each passage of the plow.

Murray, Br. . . . . * "*Engineering*," xxx. 56.
French & Amer., Paris * "*Scientific American*," xxxix. 163.

Turn'ing-off Ma-chine'. (*Knitting.*) A machine for closing hose which has been knit flatwise. See SEWING MACHINE.

Tur'nip Cut'ter. The "Picksley" cutter is a double-action machine, with a pulper disk, adjustable to fine and coarse cutting. The disk has two knives, and is so arranged that a pair of stripping plates are attachable for cutting finger-pieces.

Turnip cutters, old . . * "*Engineer*," xlvii. 474.
Turnip thinner, *Everitt, Adams & Co.*, Br. . . * "*Engineering*," xxx. 80.

Tur'nip Seed Drill. A drill for the automatic deposit of small seeds. (See Fig. 2471.)

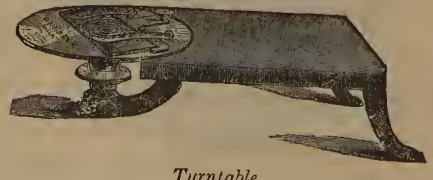
Fig. 2471.

Turnip Seed Drill.

Turn-ta'ble. (*Optics.*) An instrument for making cells of gold size or other varnish. It is revolved by one hand while the other holds the brush containing the liquid.

These instruments are supplied with various appliances for holding the slide on the center of the revolving part of the table: either springs or volute movement, beneath which actuates the clasps.

Fig. 2472.



Turntable.

Tur'pen-tine.

Tar, etc., distillation.
Zacharias . . . . "*Scientific American Sup.*," 1671.
Works in the woods . . * "*Scientific American*," xliii. 279.

Tur'ret. A report on the "*Fabrication of Iron for Defensive Purposes*" was made by Colonels Barnard and Wright, of U. S. Engineers, 1871.

Iron cased forts of Portsmouth, Britain, defenses. Plate LI.

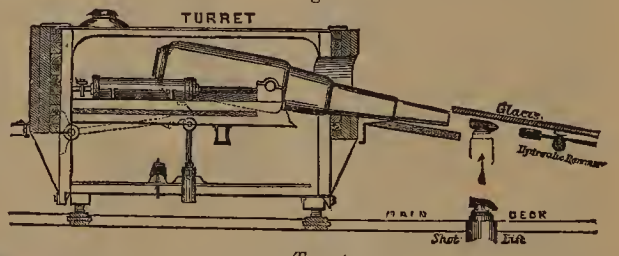
Gruson chilled iron casemate, German. Plates XXVI.–XXX.

Plate LIII. is a vertical section of a tower for harbor or land defense, having exterior and interior walls, with dome-shaped roof, revolving by gearing upon friction rollers. The artillery platforms have guns mounted upon the carriages, which radiate from the common center. The central turret revolves independently of the tower upon a shaft by means of a rod and gearing. On the left of the shaft is seen the circuit-closer, forming the connection between the galvanic battery and the conducting chains passing to each gun. Holes in the top act as ventilators, while at the sides of the turret, near the bottom, are casemates with guns, independent of the revolving tower, while below are walls of subterraneous foundation for the tower, forming chambers for stores and munitions.

Fig. 2473 is a view of the turret and glacis of the "Inflexible."

Two guns will be mounted side by side in each turret. Each gun will be mounted so as to be supported on three points. The trunnions will rest on blocks sliding on fixed beams bolted down to the floor of the turret, while the breech will rest on a third block, sliding like the others between guides, upon a beam or table. Behind each of the trunnion-blocks, in the line of recoil, are two hydraulic cylinders, connected with them by piston-rods. The cylinders communicate by a pipe, on which there is a valve, that, on the recoil of the gun, opens and allows the pistons of the rams to run back slowly, checking the recoil. By reversing the apparatus, the gun can be run out again. The beam on which the breech rests is supported by a third hydraulic ram, fixed vertically beneath it in the turret. By this means the breech can be easily raised or lowered, thus elevating or depressing

Fig. 2473.



Turret.

the muzzle of the gun, which pivots on its trunnions with a large preponderance towards the breech. In order to load, the muzzle is depressed until it comes opposite to an opening made in the upper deck before the turret, and protected by a sloping armored glacis. A hydraulic rammer works in guides through this hole, The rammer-head is hollow, and is so constructed that when it is driven into the recently-fired gun, and comes in contact with the sides of the powder-chamber, a valve opens, and it discharges through a number of holes small jets of water, thus acting as a sponge, and extinguishing any remnants of the charge or of the products of the explosion which may have remained smoldering in the bore. It is then withdrawn, and a hydraulic shot-lift raises up to the muzzle of the gun the charge, the projectile, and a retaining wad, and then a single stroke of the rammer drives them into the gun and home to the base of the bore. Again the rammer is withdrawn, the hydraulic ram under the breech of the gun elevates the muzzle, the turret swings round, and the shot is fired. A 9″ gun, mounted experimentally in a turret at Elswick, and loaded on this system, was brought to the loading position, sponged, loaded, and brought back to the firing point in twenty-three seconds. Equally rapid loading was effected with the 38-ton gun during the experimental trial of the hydraulic gear on board the Thunderer. Thus the first advantage of the system is rapidity of fire; the second is economy of labor. One man only for each gun is stationed in the turret, another works the hydraulic rammer on the main deck, six or eight others

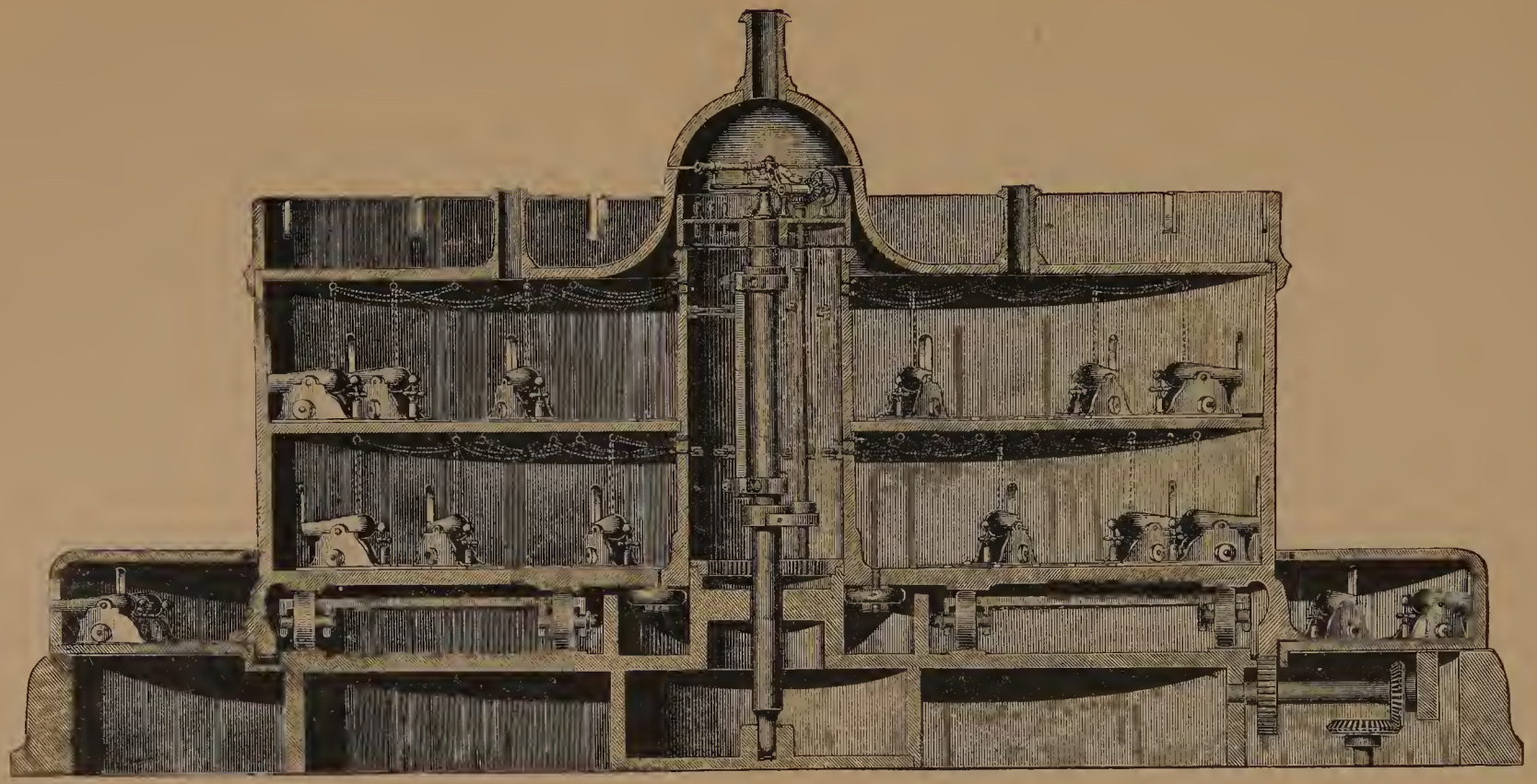


PLATE LIII. VERTICAL SECTION OF REVOLVING TURRET FOR HARBOR OR LAND DEFENSE. *See page* 908

are employed in bringing up the ammunition to the shot-lift by means of a small tramway. There are two sets of loading gear for each turret; but even if both were put out of order, the gun could still be loaded, with an ordinary rammer and sponge, by a number of men stationed on the main deck.

The adoption of the system enables very heavy guns to be carried in comparatively small turrets. Those of the Inflexible are very little larger than those of the Devastation; so that with the old plan of having a numerous crew in the turret, and running in the gun in order to load it by hand, only the 38-ton gun could be carried. As it is, it is quite possible that the Inflexible will be armed with even a more tremendous weapon than the 81-ton gun. This has been held in view in designing the ship; and, by a slight modification, it will be possible to mount in each of her turrets a pair of 160-ton guns, with a bore of 30′′ and a caliber of 20′′.

A minor feature, which will perhaps be introduced in connection with guns of large caliber, is a steel plug containing within it a detonating apparatus for firing a charge of powder. This is intended to be fixed in the vent of a heavy gun, in order to prevent the upward escape of the gas and the consequent gradual erosion of the vent. The erosion very rapidly widens the vent, and at last disables the gun, and the fire has to be suspended until it is revented. Thus this system of firing, which has been invented by Captain Noble, R. A., would greatly increase the efficiency of the gun.

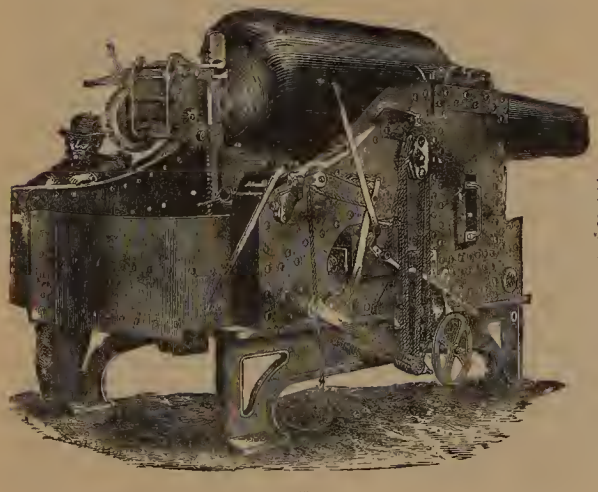
Some idea of the amount of ammunition required for the 81-ton gun will be given by the following calculation: Let us suppose that in an action the Inflexible would fire only ten shots from each of her guns; she would use up more than $6,500 worth of ammunition, burn upwards of 100 barrels of pebble-powder, and hurl nearly thirty tons of iron at the enemy.

"Inflexible," Br. . . * "*Engineer*," xliii. 435.
"Thunderer," Br. . . * "*Engineer*," xlvii. 19.
Clock, Bombay Univ., *Smith*, Br. . . . . * "*Engineer*," xlii. 395.
Lathe, *Harrington* . . * "*Iron Age*," xix., June 28, p. 1.
Screw machine, *Pratt & Whitney* . . . . . * "*Thurston's Vienna Rept.*," ii. 226.
Ship, "Miantonomah" * "*Engineer*," xlix. 278.

Tur'ret Gun. (*Ordnance.*) One specially arranged to be used in a revolving turret. The peculiarity of guns of this class consists in the fact that their horizontal traverse is effected by the motion of the turret itself, the position of the carriage, with respect to the turret, being invariable.

Fig. 2474 illustrates an 18-ton gun and carriage. The brackets each consist of an inner and outer plate of ⅞′′ wrought iron, stiffened by cast iron frames. The trunnions fit accurately between the brackets, having a play of but 1-32 of an inch, and serve to brace them; 1-32 of an inch play is also allowed between the carriage and platform, making the maximum deviation from the true line of sight but 1-16 of an inch. The elevation is effected on what is known as the principle of *compound pivoting*, the gun being raised or lowered by means of a hydraulic jack. The trunnions rest in blocks fixed on the extremities of a curved piece of wrought iron with steel side-pieces, termed the saddle, underneath the center of which the jack is placed; they may be supported at three different elevations on supporting

Fig. 2474.



Turret Gun.

blocks or steps of suitable height. On the highest step the gun may be laid at any angle between 6° depression and 3½° elevation; on the intermediate step between 2° depression and 7° elevation, and in the lowest position between 7° and 13° of elevation; it is shown in the figure in its highest position. The elevating apparatus consists of a straight vertical rack operated by a hand-wheel through the medium of a series of gears.

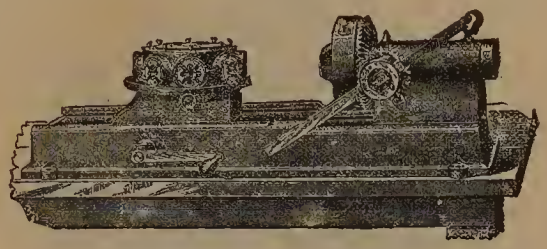
A second hydraulic jack is provided for the purpose of bringing the rollers into action upon which the gun is run out; in case of accident to the jack, tackles at the sides of the carriage are employed for this object.

Wedge-shaped iron plates depending from the brackets and fitting between corresponding plates on the slide act as compressors to limit the recoil of the carriage; and if required, additional friction may be obtained by means of a compressor screw and handle.

Tur'ret Head. The revolving head of a bolt cutter.

In Fig. 2475 the cylinder may be revolved at will, is secured in position by a spring bolt, and holds on its periphery seven

Fig. 2475.



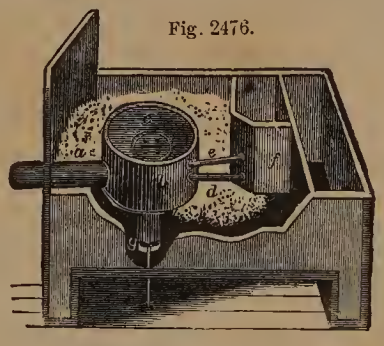
Turret-head Hand Bolt Cutter.

dies, either one of which may be presented instantly to the bolt to be cut, and carried forward by a crank, pinion, and rack. The cylinder holds also a collet, adapted for recessed plates, to receive square and hexagonal nuts of different sizes for tapping purposes. This collet is secured and removed readily, as are also the dies. The revolving spindle is hollow, to receive bolts of any length, and by removing the collet opposite the one that is at work, allowing the bolts to pass through the head, the thread may be cut to any distance required. The spindle is furnished with a chuck for holding the bolt or the tap, and it is driven by a crank, adjustable in length, and by bevel pinion and gear.

Tuy-ere'. A tube for regulating and directing the current of air to the fire in a forge or furnace.

In Bayliss's vertical hot blast and water tuyere and forge, instead of the blast passing into the fire cold, as in the ordi-

Fig. 2476.



Hot Blast Tuyere.

nary tuyere, it passes through a pipe, *a*, and takes a circle of the air chamber *b*, and enters the fire at a temperature of 300° through nozzle *c*, which is a hollow casting filled with water from an iron tank, *f*, by pipe *d*. The steam generated in the nozzle is conveyed to the tank by pipe *e*. Air is admitted to the air-chamber *c* through pipe *g*.

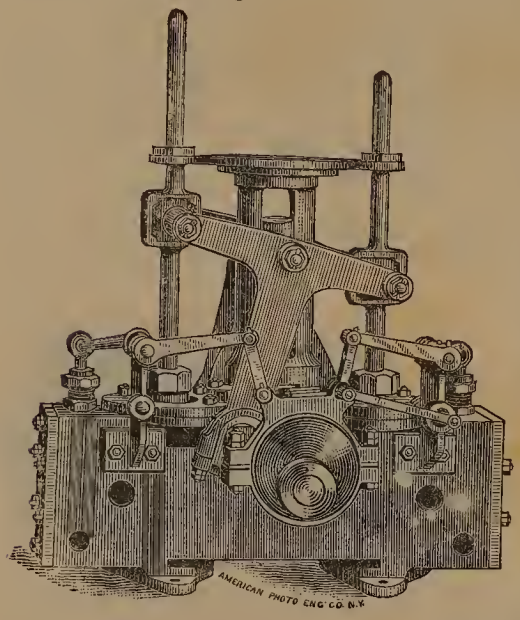
Lloyd's tuyere is an open spray blast for a furnace.

Safety, *Lloyd* . . . . * "*Iron Age*," xvii., June 27, p. 5.
* "*Scientific American Sup.*," 68.
Spray, *Plum* . . . . "*Iron Age*," xxii., Aug. 15, p. 15.
On, *Tawes & Hartman* . "*Iron Age*," xxii., Aug. 22, p. 7.

Tuy-ere' Coil. A convoluted pipe carrying water through a tuyere to mitigate the heat to which the tuyere is exposed in the fire. See "*Mech. Dict.*," Fig. 6827, p. 2666.

Twin Cyl'in-der Steam En'gine. In Fig. 2477, Bernay's twin cylinder engine, the general principle consists in placing the crank-shaft in the center line between the two cylinders, and making the connection between the crank and the two pis-

Fig. 2477.



Twin Cylinder.

tons by means of a triangular connecting-rod, one side of which (that opposite the crank) is guided in a cross-head. The arrangement for correctly distributing the steam consists in directing the motion of the slide-valves of both cylinders by means of one eccentric in a manner analogous to that by which the motion of the two pistons is directed through their triangular connection with one crank. The eccentric ring has two eyes prepared on it, whose up-and-down motion alone is made use of, and to which the valve levers or rods are hung. Straight lines drawn between these two eyes on the ring, and from the eyes to the center of the eccentric, constitute a triangle which bears the same relation to the eccentricity, or throw of the eccentric, as the triangle of the main connecting-rod bears to the throw of the crank. Any kind of expansion valves, and also link-motion, can be used with this engine.

For twin engines, boilers, screws, etc., see —

Ball, N. Y. . . . . * "*Iron Age*," xx., July 5, p. 15.
Boat, Sailing Proa, "Ladronia" . . . . * "*Scientific American*," xlii. 150.
Boilers, *Smith & Alexander*, Br. . . . . * "*Engineering*," xxv. 27.
Screw . . . . . * "*Scientific American Sup.*," 2715.
SS. "Iris," Br. navy * "*Engineer*," xlvii. 301.
* "*Engineering*," xxvii. 330.
Engine and boiler, *Wilson*, Engl. . . * "*Scientific American Sup.*," 1071.
Gunboat engines, Motala Works, Sweden "*Thurston's Vienna Rept.*," ii. 59.
Launch, Br. Navy . . * "*Engineering*," xxv. 406.
Launch engine, *Wilson*, Br. . . . . * "*Engineering*," xxiii. 91.
Propeller, *Hunt* . . * "*Scientific American*," xxxvii. 1.
Propeller engine. *Whiting* . . . . * "*Scientific American Sup.*," 141.
Steamboat, *Stevens* (1804) . . . . . * "*Engineering*," xxv. 72.
Ship "Castalia" . . . * "*Engineering*," xxvii. 334.
"*Scientific American*," xxxiv. 163.
"Express," Calais to Dover . . . . . "*Van Nostr. Mag.*," xviii. 477.
"*Engineer*," xlv. 197.
Trial trip of (Dover to Calais . . . . . "*Scientific Amer.*," xxxviii. 247.
Bernays, Br. . . . . * "*Engineering*," xxv. 353.
Watts, Br. . . . . * "*Engineering*," xxvi. 118.
Wigzell & Halsey . . . * "*Scientific American Sup.*," 1184.

Twin Fur'nace. A double furnace.

Twin Lo-co-mo'tive. Two locomotives, identical in their parts, attached to a long freight platform.

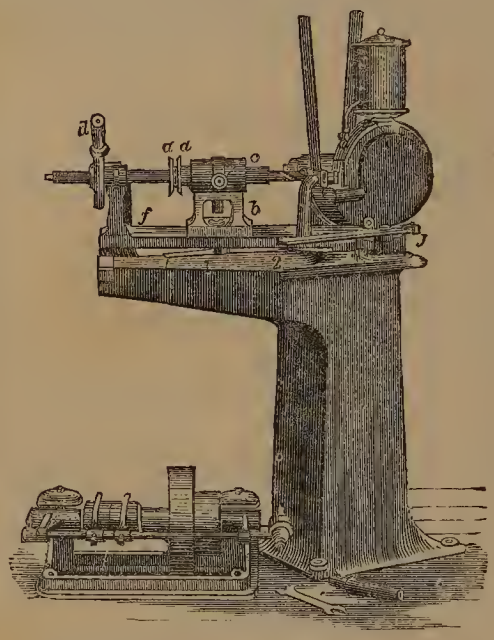
Twin locomotive . . . * "*Scientific American Sup.*," 2717.
Villa Real Railway, Portugal . . . . * "*Engineering*," xxvi. 511–515.

Twin Pow'er Press. One in which the power is brought to bear upon two objects in alternation. See Fig. 916, p. 291, *supra*.

Twist Drill Grind'er. This machine, Fig. 2478, is designed for sharpening twist and other drills from $\frac{1}{4}''$ to $1\frac{1}{2}''$ in diameter, and of any length. All the movements are self regulating and automatic.

The head-stock of the emery-wheel has a transverse movement actuated by a lever, and is also capable of being set forward relatively to compensate for wear.

Fig. 2478



Twist Drill Grinder.

The shank of the drill is held in a hollow arbor, the other extremity being supported near the grinding-wheel by a ring in which the drill is centralized by a screw.

The cut is made with mathematical precision, and the presentation is such that the length and angle of cut on the respective sides of the drill are exactly equal.

The emery wheel is kept wet by a trickling stream of water, elevated by a small rotary pump on the wheel arbor, and conducted by pipes from a reservoir in the post to the hood of the wheel; from the drip mass it returns by a pipe to the reservoir.

The pulley has two speeds, and the more rapid may be used when the emery wheel has worn to a smaller diameter, so as to preserve proximately the same speed at different periods in the life of the stone.

The drill-holding portion has a radial adjustment on the point of contact with the stone as a center, to govern the angle of presentation of the drill. A series of 41 rings, adapted to all sizes of drills, goes with the machine.

Thomson, Sterne & Co., Br. . . . . * "*Engineering*," xxi. 23.
Fay . . . . . * "*Scientific American*," xxxv. 326.
Twist drills, on . . . "*Manuf. and Builder*," xi. 163.

Twilled Ar'mure. (*Weaving.*) A style of weaving produced by the four-leaved harness, making a twill. Also called *Batavia weave*. See ARMURE.

Twist'ing For'ceps. (*Surgical.*) See TORSION FORCEPS.

Twist'ing Ma-chine'.

Yarn. . . . * "*Scientific American Sup.*," 1075.

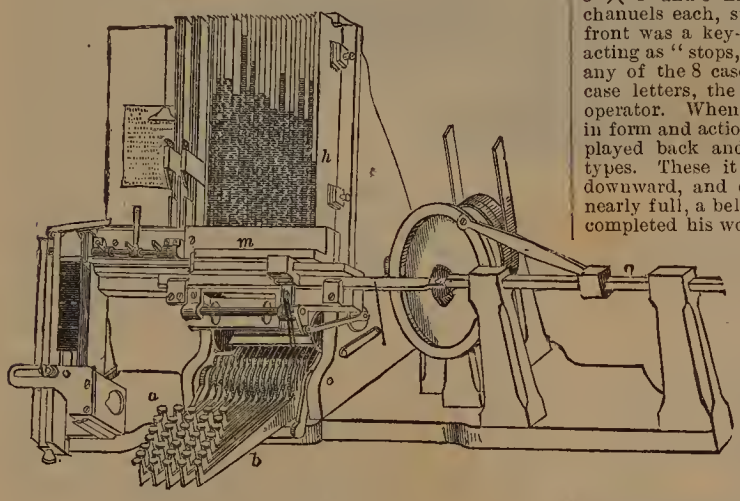
Ty'er Bat'te-ry. (*Electricity.*) The positive element consists of fragments of zinc in a bath of mercury at the bottom of the cell. The negative element (copper) is suspended above in dilute sulphuric acid.

Niaudet, American translation . . . . . * 57.

Baron Ebner's modification consists in replacing the copper by a plate of platinized lead.

Niaudet, American translation . . . . . 58.

Fig. 2479.



Paige's Type-composing Machine.

Tym'pa-num Per'fo-ra-tor. (*Surgical.*) A fine, piercing instrument for perforating the tympanum. *Politzer.*

Forceps made specially for the purpose are used to introduce an eyelet into the perforated tympanum.

See page 37, Part II., *Tiemann's "Armamentarium Chirurgicum."*

Type. Nickel is now used in electrotyping, giving a smooth, hard face to the type.

Type Com-pos'ing Ma-chine'.

Paige's type-composing machine has keys by which the different *sorts* are dropped in the required order from the receptacle pockets *h* (Fig. 2479), which contain them. The keys are shown in a group, *a*, in the lower part of the illustration, the right-hand lower one of the set being shown at *b*. The main shaft of the machine is kept constantly revolving, and when a key is depressed, the mechanism at a certain portion of the revolution causes the appropriate type-forcer to push out the lowest type of the rank into the race *m*, when the type-driving rod *o* sweeps it out of the race and into the line of composition, when the justifying mechanism *c* comes into play to form the matter in lines for the galley measure.

The "Felt" machine, patented May 29, 1860, and June 23, 1863, was the first machine constructed to set, justify, and distribute. It attempted too much. It occupied a space 5′ × 4′ and 8′ high, and had 8 type-cases, consisting of 36 channels each, standing perpendicularly, side by side. In front was a key-board of 40 keys, like that of an organ, 7 acting as "stops," which adjusted the keys in relation with any of the 8 cases. Thus the keys acted upon the lower-case letters, the capitals, or the *italics*, at the will of the operator. When the machine was in motion, the "stick," in form and action suggesting the head and beak of a bird, played back and forth against the tubes, gathering the types. These it seized with its pincers, or beak, turned downward, and deposited in the line. When the line was nearly full, a bell announced it, so that the compositor only completed his word or syllable. By touching now the justifying-key, he caused the spacer to draw the line into another part of the machine to be justified, and so resumed his setting. The process of justifying consisted in the removal of the steel spaces, with which the matter was first set, and which were furnished with projecting heads for the purpose of withdrawal, and substituting others. This process was performed automatically, the lead added, and the line deposited on the galley. In distribution, the necessity of nicks in the type was sought to be avoided by means of a register, made in the process of composition. This consisted of a narrow strip of card or paper, in which holes were punched as the types were taken, and by which they were redistributed.

Type-casting machine . * "*Scientific American*," xlii. 8.
Type factory . . . . * "*Scientific American*," xlii. 239.
Type printing telegraph, *Vander Ploeg* . . * "*Telegraphic Journal*," vi. 417.
Instruments, Engl. . "*Scientific American Sup.*," 1173.
Type setting machine, *Heinemann* . . . "*Mining & Sc. Press*," xxxvi. 99.
And distributing machine, *Burr* . . . * "*Manufact. and Builder*," xii. 83.

U.

U Bolt. A clevis for the attachment of axles, rods, etc., in machinery and vehicles.

U-cha'ti-us Steel. (*Metallurgy.*) Iron, granulated by running it into cold water, is put into a crucible with oxygen-yielding material, such as spathose iron ore, and the pig-iron gives up its impurities to the oxygen.

Uchatius steel . . . "*Van Nostr. Mag.*," xv. 282, 474.

Un-bran'ning Ma-chine'. (*Milling.*) A machine for removing the bran or cuticle of the wheat grain. The Bentz process.

The process is partially accomplished by a vigorous application of brushes arranged as in the smut machine; also by scalding, which makes the cuticle roll off when rubbed. See SMUT MACHINE.

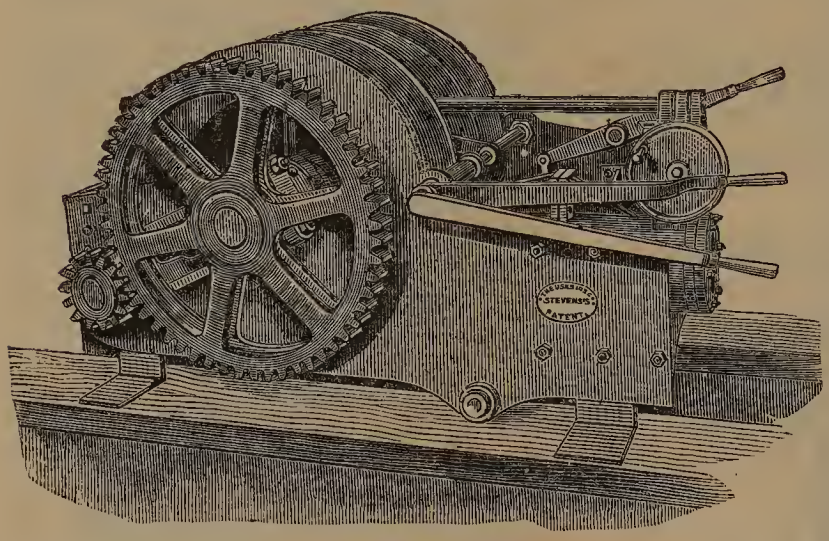
Un'der-grade. A term as applied to bridges synonymous with *deck* bridge, in which the track is above the truss.

Un'der-ground Haul'ing En'gine. Stevens's underground engine, Fig. 2480, exhibited at the Leeds Exhibition, is specially designed for underground haulage, and the object has been to provide an engine, with drums and everything complete, which shall do the work of four or five horses, and be so small and compact that it will pass underground through any space which is sufficient for an ordinary coal train. The engine is completely erected between two frames of boiler-plate, and the one exhibited, which will indicate about 6 horse-power with 20 lbs. pressure, and is fitted with 2 drums of 2′ diameter, occupies a space of 6′ 7″ by 4′ by 3′ 5″, and weighs 29 cwt. In using these engines no foundation is required, all that is necessary being to spike them down on timber. The drums which work on the second motion are loose on the shaft, and have independent brakes and a clutch for throwing them in and out of gear.

These engines are designed for using compressed air or steam; for the former the exhaust passages are made very large. Most of the new collieries that are now in progress of laying out are being arranged to use mechanical haulage.

Fig. 2481 is a view of the Uskside underground engine.

Fig. 2480.



Stevens's Underground Hauling Engine.

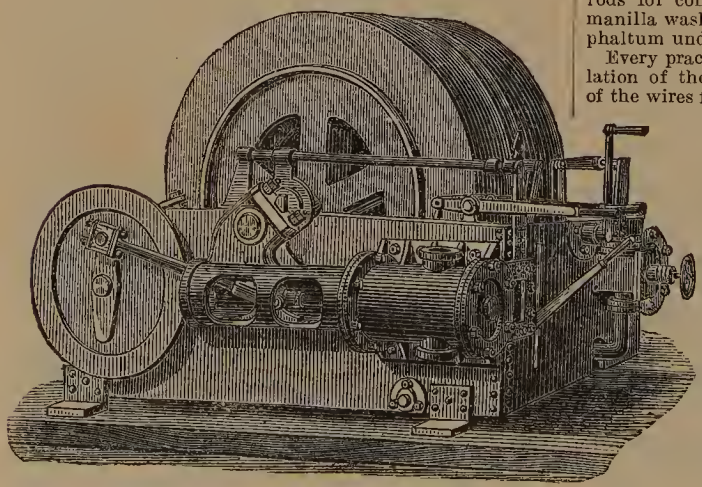
Fowler, Br. . . . . * "*Engineering*," xxvi. 5.
Stevens, Br. . . . . * "*Engineering*," xxvi. 224.
Underground railways . "*Iron Age*," xxi., Jan. 10, p. 15.

Un'der-ground Wires. For telegraph, telephone, and other electric uses.

Underground electric ways arose with the electric telegraph. Messrs. Cooke and Wheatstone, in their earliest telegraph patents, No. 7390 of 1837, and No. 7614 of 1838, describe means for inclosing line wires in conduits to be used underground or placed upon posts above ground. Wooden rails were channeled or grooved upon their surface, and the wires laid in a resinous cement in the grooves. A second rail was then placed upon the first and bound down with iron bands. The wires were covered with cotton and varnished before being laid. They also used various shaped troughs and tubes, into which carefully insulated wires or cables were drawn. Iron tubes, like gas-piping with screwed joints, were laid down, and wires or cables drawn into them. A long coupling sleeve formed a junction-box for connecting up the wires. They also employed a split-iron tube, in the slot of which wires were introduced. The insulating material was poured in upon the wires and the edges of the slot drawn together.

In 1845, Patent No. 10,799, cotton-covered wires were placed in a lead pipe and pitch poured in, the lead pipe being used for the return circuit. In the same year, Patent No. 10,838, wires were laid in railway fences and at crossings, were brought underground and embedded in asphalt. In 1847, patent No. 11,974, parallel grooves were made in sleepers of wood, stone, concrete, or earthen-ware, the wires were then laid therein and supported by insulating supports, marine glue, gutta-percha, asphalt, or Stockholm tar was then poured in hot and an iron cover screwed down over the grooves. In some cases each wire was covered with cotton and then encased in lead. In 1850 Mr. Siemens used a plow, on the carriage of which was a reeled cable. The cable was laid down in the furrow as it was cut by the plow, and then covered under, *vide* Patent No. 13,062. In pateut No. 2,710, of 1854, perforated or grooved blocks were made of artificial stone composed of bitumen, sand, and other ingredients. These were molded into the proper shape, and laid in line, and then bare or insulated wires threaded through the perforations. The wires were stretched tight and carefully joined. At the testing and junction boxes the wires were brought out and laid in a notched frame, so as to be readily accessible. Patent 2,089 of 1855, by Dr. Werner Siemens, is of interest as being the first attempt to avoid induction and the consequent retardation. In a cable for underground or submarine use two parallel wires are laid in gutta-percha insulation and one used as the return conductor for the other. As the current in the two is in opposite directions, each neutralizes the inductive effect of the other. Other wires placed in the same cable are each equidistant from the first two wires so as to be equally and oppositely affected by them. In one form a central insulated copper wire is surrounded by a number of iron wires which form the return part of the circuit of which the copper wire is the direct.

Fig. 2481.



The Uskside Underground Hauling Engine.

Patent 119 of 1859. An iron trough laid beside the curb-stone contains the wires.

Patent 2,759 of 1859. Earthenware troughs are provided with hooks or notched projections or frames of insulating material on which the wires are supported. The troughs are covered up and sealed with pitch.

Patent 130 of 1868. A conduit of molded blocks of earthenware, with perforations for the wires. The wires are drawn in by pneumatic pressure or by percussion.

Patent 3,863 of 1873. The wires are supported in pipes by means of perforated disks. Dry air is forced into the pipes to absorb moisture and maintain the insulation. The air is dried by being passed over quick-lime or sulphuric acid and pumice-stone. The pipes are of glass, cement, composition, or earthenware.

In the United States but comparatively little has yet been done in underground electric ways, and most of the devices are small modifications of those described above.

In the Brooks system, Patent No. 165,535, July 13, 1875, wires covered with jute or cotton and soaked in paraffine are placed in an iron tube and the tube then filled with heavy paraffine oil or liquid paraffine which is maintained under pressure. Horner, Patent No. 173,170, February 6, 1876, uses a hollow curb-stone in which there is a box or tube containing properly insulated wires. Delany, Patent No. 240,236, April 19, 1881, places within his conduit a pipe for conducting hot air or steam which prevents moisture injuring the insulation. He insulates with powdered talc. Edison, Patent No. 251,552, December 27, 1881, uses semi-cylindrical rods for conductors which are supported in iron tubes by manilla washers; the tubes are then filled with melted asphaltum under heavy pressure.

Every practical underground way involves complete insulation of the wires, protection from moisture, accessibility of the wires for connections and testing, and means for adding new conductors as the needs of the service increase. Perhaps the greatest desideratum, however, is the prevention of induction between different classes of wires. The device used by Siemens has been mentioned. A device, invented by Foucault, Patent No. 90,089, May 18, 1869, is to surround each insulated wire with a thin metallic layer, which is connected to the ground at intervals. This metallic layer is supposed to take up the inductive energy of the wire, and prevent its disturbing action on the neighboring wires.

The first practical device, however is of recent American invention, having been patented to the inventors, Messrs. Beutley & Knight, May 1, 1883. Electric light, telephone, and telegraph wires are all laid in the same conduit. In one form the light wires are run up one side of the conduit and return down the opposite side. Between them are the telephone wires, which cross over at intervals from one

side to the other of the conduit, so as to be equally and oppositely influenced by the two branches of the light-circuit. The telegraph lines consist of cables wherein a common return is used for a number of direct lines and neutralizes their inductive effect. In a second form the light wires are crossed at intervals, so that the positive and negative wires exchange their lineal positions; the telephone wires are straight, while the telegraph wires are cabled as in the first arrangement. In a third form the telephone and telegraph wires are both single and are each equally distant from the two branches of the light circuit. The light conductors are made in strips and serve as inductive shields between the telephone and telegraph wires.

The underground telegraph wires of the French cities are thus arranged: The conductor, formed of a wire-cord of four strands, spirally twisted, is covered with a sheath of gutta-percha of about 5 millimeters in diameter, and surrounded by a covering of cotton saturated with wood-tar, and another not so saturated. These envelopes of cotton are dipped in sulphate of copper solution. The cables contain from 3 to 7 conducting wires, according to the needs of the service. They are laid in cast-iron pipes similar to those used for gas, 2½ meters in length, and of a size proportioned to the number of cables. The lengths of a pipe are united by leaden rings; every 50 meters there is a joint of larger diameter, which slides over its neighbors like a sleeve. At the moment of laying the pipes in the trench dug to receive them, a thread is passed through the pipe, which, at the adjustment of each length of 200 meters, introduces a larger cord; one of the ends of this cord is rolled upon a winch, and the other attached to a small iron bar mounted with "gudgeons," which hold the cables to be inserted. The cable is thus drawn through the pipe, passing first over a pulley whose horizontal tangent is in a line with the pipe. If the joints are well made, the pipe is weather-proof, and the cable is sheltered from all infiltrations of water or of gas. The use of the larger joints of pipe above mentioned makes the repair of the cables in case of accident an easy matter.

The wires are run underground in the cities of Berlin, Dresden, Breslau, Dantzig, Stettin, Hamburg, Bremen, Cologne, Frankfort-on-the-Main, Mayence, Carlsruhe, and other large cities and towns of Germany, and in Geneva, Lausanne, Berne, Neufchatel, Zurich, Winterthur, Schaffhausen, Saint Galle, and Lugano, in Switzerland. In nearly all the cities of Europe neither posts nor wires are visible, but the system of underground cables is adopted instead. These cables contain from 5 to 7 conductors each, insulated with gutta-percha, and the whole protected with an armor of iron wires. This system has shown itself in practice to be both economical and reliable. There are now in Paris working lines that have been buried for twenty years, and which have been the cause of little or no expense except their first cost. It is especially worthy of note in this particular that during the reign of the commune, when almost every institution of public utility was destroyed, not an underground wire was disturbed.

London . . . . . "*Iron Age*," xvii., March 16, p. 3.
"*Telegraphic Journal*," iv. 26, 97.
England . . . . . "*Scientific Amer.*," xxxvii. 278.

U'ni-cy'cle. A one-wheeled vehicle for propulsion by foot-power.

A Danish inventor has invented a single wheel in which is arranged a seat for the traveler who is to propel it. The wheel has one central rim, and to this are fixed the arms, which are, say, six or eight in number, half of them swelled, extended, or bellied out to one side, and half of them similarly to the other side, each set of arms being fixed to a nave or boss; these arms are bent out so far and the naves are so far apart that the traveler, when in the sitting posture, finds room in the wheel between them. The arms are by preference not arranged opposite to one another on the two sides, but intermediately. The naves carry each a crank, and these cranks are by connecting rods jointed to two bell-crank levers, having one arm placed about upright in a position convenient to the traveler to take hold of for working them backward and forward alternately. Each bell-crank lever has its fulcrum in the seat for the traveler, which seat is hung from the naves or axles of the wheel. The seat is by preference made in scroll form, of light, open-worked steel plate or wire-work, or partly so, and may have a part extending overhead to carry an awning to protect against dirt thrown up, and against rain. From each nave there may be hung a leg serving to steady the velocipede while entering the same, but which can be thrown up out of the way when traveling. The wheel, arms, and the rim may be fitted with stiffeners or diagonals to distribute the weight or strain over the rim as much as possible. This unicycle is eight feet and upwards in diameter.

U'nit. A basis for estimating or forming comparisons.

"One pound of good anthracite coal will produce, in combustion, 14,220 units of heat; while 1 lb. of bituminous coal will produce 13,500 units. Let us adopt the round number, 14,000 units: that is to say, the proper combustion of 1 lb. of coal should heat 14,000 lbs. of water 1°, or 140 lbs. 100°, or 14 lbs. 1,000° Fahr. But heating water 1,000° changes it into steam; and experiments have proved that it takes exactly as much heat to change 14 lbs. of water into steam as to heat 140 lbs. of water 100°. Therefore the 14,000 units of heat developed by the combustion of 1 lb. of coal will change 14 lbs. of water into steam; and it is by the intervention of this steam that we have to obtain the mechanical equivalent of the 14,000 units of heat. The well-established mechanical equivalent of each unit is 772 foot pounds. In fact, for every foot that we cause 772 lbs. to descend, we may actually obtain a unit of heat; and therefore we are entitled to expect inversely the development of a force of 772 foot pounds for every unit of heat expended. The 14,000 units of heat, obtained by the combustion of 1 lb. of coal, should give us, then, 14,000 × 772, or 10,808,000 foot pounds. If the coal is burned in 1 hour, we ought to obtain this force per hour; and, as 1 horse power is equal to a force of 33,000 foot pounds per minute, or 33,000 × 60 = 1,980,000 foot pounds per hour, we ought to have 10,808,000 ÷ 1,980,000, or 5.4 horse power per pound of coal consumed per hour. The best engines, therefore, in place of obtaining, as heretofore, only one tenth or one twentieth of the theoretical equivalent of the heat consumed, are reported to have reached nearly one fifth, which is certainly a wonderful advance. Of course, the full theoretical equivalent can never be expected, for reasons which we will not now discuss. Most engineers are agreed on the main features of the most economical steam engines. They are: Proportionally large boilers, with large heating surfaces, and proper grates; heating of the feed-water in the condenser; high pressure in connection with proper cut-off arrangements, so as to utilize the expansion; careful protection from loss of heat by radiation, and intelligent and faithful engineers and firemen." —*Technologist.*

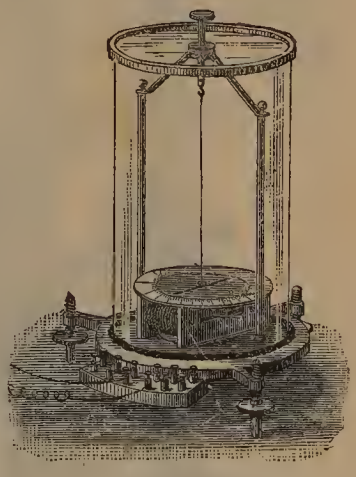
Unit of light: —

England: Spermaceti candle burning 8 grains per hour.
France: A carcel lamp burning 42 grams colza oil per hour.
Germany: A spermaceti candle giving 1-9 the light of the Fresnel unit.

U'nit and Safe'ty Valve. One exposing 1 square inch to the force of the steam.

U'ni-ver'sal Gal'va-nom'e-ter. Edgerton's apparatus, Fig. 2482, has leveling screws and astatic needles, suspended from the brass arm by a fiber of unspun silk, with arrangement for adjusting the zero of the scale to the axle of the coils.

Fig. 2482.



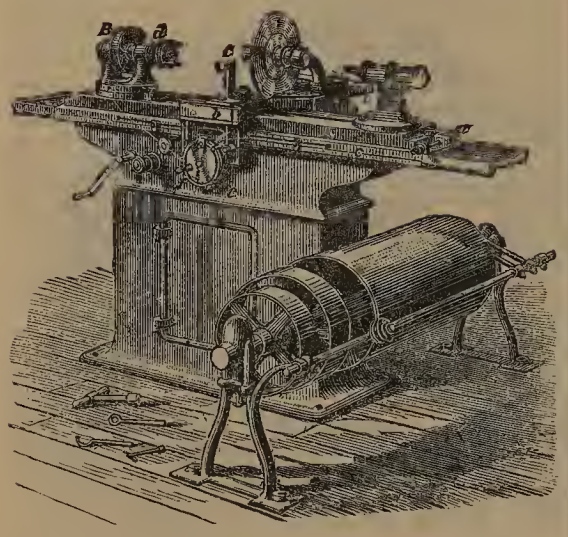
Universal Galvanometer.

It is convertible by adjustment from an ordinary quantity galvanometer into one for intensity or into a differential galvanometer for either intensity or quantity.

U'ni-ver'sal Grind'ing Machine'. One adapted for a great variety of work, with solid emery or corundum wheels.

The movable table is capable of adjustment by a tangent screw and graduated arc, and admits of straight and curved taper grinding with the centers of the machine always in line. It is specially adapted for grinding soft or hardened spindles, arbors, cutters, either straight or angular, reamers and standards also for grinding out straight and taper holes, standard rings, hardened boxes, jewelers' rolls, etc. The work can be revolved upon dead centers or otherwise. The grinding wheel can be moved over the work at any angle, by which means any taper can be produced. Emery wheels from ¼" to 12" in diameter can be used either with or without water. The feed-works and slides of the machine are

Fig. 2483.



Brown and Sharpe's Universal Grinder.

covered and protected from grit and dust. The grinding of taper holes and angular cutters is provided for with graduated arcs.

U'ni-ver'sal Head. A portion of a watchmaker's lathe with face-plate and dogs for holding the work. See WATCHMAKER'S LATHE, where it is shown in connection with a jeweling rest.

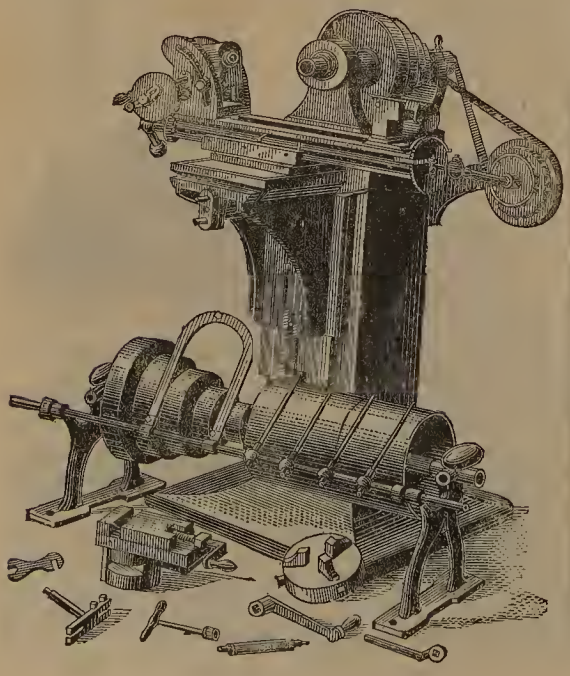
U'ni-ver'sal Joint. For diagrams, illustrations, and calculations; see *"Joint Universel,"* in *Laboulaye's "Dictionnaire des Arts et Manufactures,"* tome ii., ed. 1877.

U'ni-ver'sal Lathe. One for producing various forms, either circular or irregular.

Koch & Muller . . . . . * *"Engineer,"* xli. 26.

U'ni-ver'sal Mill'ing Ma-chine'. (*Metal Working.*) A milling machine with a capacity and variety of adjustments of the tools and tables, to enable it to do a great variety of work.

Fig. 2484.

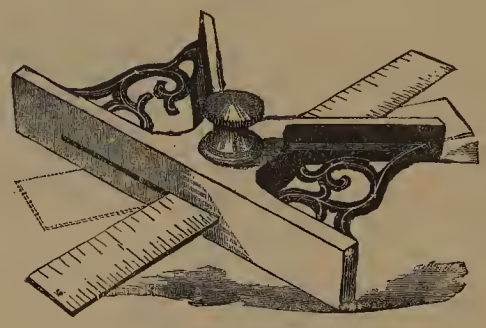


Brown and Sharpe's Milling Machine.

In addition to the movements of a plain milling machine, the one shown in Fig. 2484 has the following: The carriage moves and is fed automatically, not only at right angles to the spindle, but at any angle, and can be stopped at any required point. On the carriage centers are arranged in which reamers, drills, and mills can be cut either straight or spiral. Spur and beveled gears can also be cut. The head which holds one center can be raised to any angle, and conical blanks placed on an arbor in it, cut straight or spirally. Either right- or left-hand spirals can be cut.

U'ni-ver'sal Square. A combined try-square, miter, T-square, rule, and center square for finding the center of a circle. See SQUARE.

Fig. 2485.



Universal Try Square.

Marshall's center square, Fig. 2485, combines in one seven different tools: the try-square, miter, T-square, bevel, center square, depth gage, and the graduated rule.

U'ni-ver'sal Wood Work'er. The Fay wood-worker, Fig. 2486, is a machine in which both sides may be operated, and either side started or stopped without interfering with the other.

As a planer, it is adapted for ordinary surfacing and thicknessing, planing out of wind, surfacing square, beveling, or tapering pieces, facing up bevels and baluster, etc. As a molding machine it will work moldings, either simple or complex, up to 8″ or 9″ in width, stick sash and doors, tongue and groove; and on the wood-worker side it will produce waved, oval, elliptical, circular, and serpentine and rope or twist moldings. Among its other uses are chamfering, cornering, rabbeting and joining window blinds, gaining, panel-raising on one or both sides, tenoning, ripping, cross-cutting, grooving, hand-matching, making glue and table joints, mitering, nosing, squaring up, and a multiplicity of other operations limited only by the skill of the operator.

The molder and wood-worker sides are securely connected upon one solid column with a substantial base, and the two sides of the machine are driven from one countershaft, which conveys power either separately or simultaneously.

The molding side is so arranged as to form a complete four-side molder. The side spindles are fixed to and move with the table, which has a vertical movement of 16″. The feeding rolls are arranged for fast or slow feed.

The wood-worker side is constructed on the same principle and embraces the same general features as the patent variety wood-worker above described.

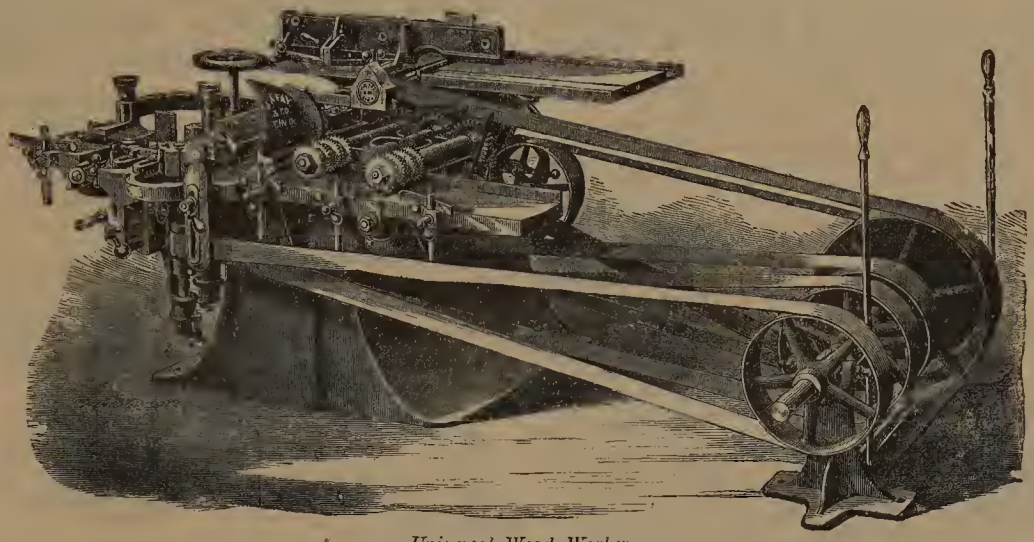
Un-load'er.

Hay, *Kelly* . . . . . * *"Min. & Sc. Press,"* xxxvi. 238.
Winter . . . . . * *"Min. & Sc. Press,"* xxxvi. 313.

Up-end'ing Tongs. A long and strong suspended tongs to enable the shingles to tip the bloom on end on the anvil that the hammer may strike it endways and upset it.

Head . . . . . * *"Engineering,"* xxiii. 429.

Fig. 2486.

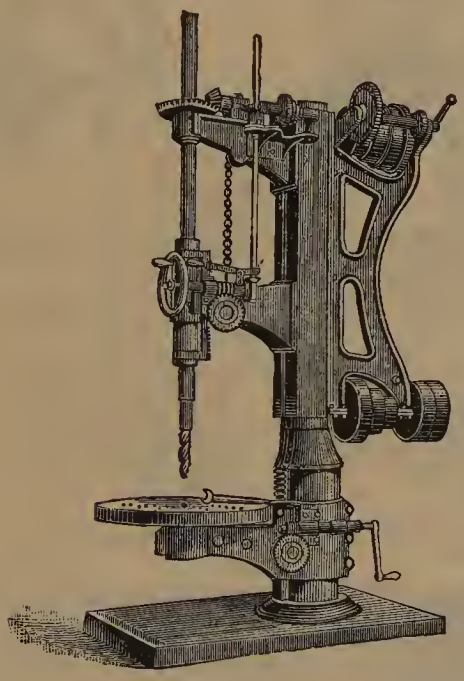


Universal Wood Worker.

Up'per Deck. (*Nautical.*) The highest continuous deck.

Up'right Drill. (*Metal Working.*) A term

Fig. 2487.



Upright Drill.

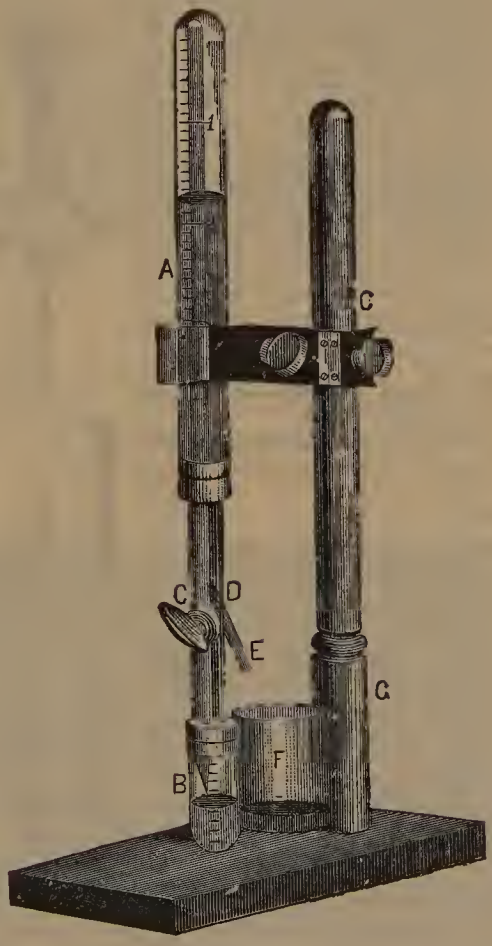
applied to a drill whose mandril is vertical, as in Fig. 2487. See also DRILL; BORING MACHINE, etc.

Ferris & Miles . . . . * "*Iron Age*," xx., Nov. 15, p. 1.

Up'right Mold'ing Ma-chine'. Blaisdell's upright molder has an adjustable table, operated by turning the wheel around the column. The spindle is placed in boxes inside the column, and into this the false spindle is fitted by a new device. The main spindle runs in self-oiling brass boxes.

U're-om'e-ter. In Hüfner's new ureometer, Fig. 2488, for clinical use, the exact methods for the determination of urea in organic liquids are far too complex and tedious to be of more than occasional service to busy medical men, whilst the readier methods are not sufficiently accurate to be of more than approximate value. The method of estimating urea by means of a solution of sodium hypobromite, given by Hüfner, and the modification of it proposed by Russel and West, are very

Fig. 2488.



Ureometer.

convenient for clinical purposes, but even these leave something to be desired on the score of accuracy.

In a recent January number of the "*Practitioner*," Drs. Russel and West state that they have found the hypobromous solution to decompose in hot weather more quickly than they expected, and that it is very important that it be freshly prepared.

They draw especial attention to this, and suggest that the solution be prepared in the following manner: —

A solution of caustic soda is made in water, in the proportion of 100 grams of solid caustic soda to 250 cc. of water. This solution may be made in large quantities, for it will keep good for a very long time. To part of this solution bromine is added, in the proportion of 25 cc. to every 250 cc. of caustic soda solution, at the time it is required for use.

With the view of simplifying the operation of ureometry to the utmost extent compatible with the necessary accuracy, M. J. G. Blackley, of London, devised the form of apparatus represented in the cut. It consists of two graduated tubes, a larger one, *A*, of about 75 cc. capacity, and a smaller one, *B*, of about 15 cc. capacity, closed by perforated india-rubber stoppers, through which pass the tubes *C* and *D*. *C* is the wider of the two, and is provided with a glass stop-cock. Its lower extremity, drawn to a fine point, descends about halfway into the tube *B*. *D* is a narrower tube, and ascends about halfway inside *A*. *E* is a short, slightly bent tube, passing through the india-rubber stopper into the tube *A*, and serving as an egress for the superfluous contents of *A*, which are collected in the beaker *F*, the whole being supported by the wooden stand *G G*.

The method of using the apparatus is as follows: —

The tube *A* is filled with a solution of sodium hypobromite, and its stopper inserted. Then 5 cc. of the liquid to be examined are placed in the tube *B*, and its stopper (which has previously been adjusted upon the ends of the glass tubes *C* and *D*) is inserted to the level of a scratch on the outside, and the stop-cock gradually opened. The hypobromite solution flows down the tube *C*, decomposition takes place, and the gases evolved, ascending through the tube *D*, are collected in *A*. The superfluous hypobromite solution flows out through the tube *E* into the beaker *F*. To complete the operation the apparatus is removed from the stand, after placing the finger over the mouth of the tube *E*, and agitated for a few moments. It is then replaced, and after allowing time for the froth to subside, the quantity of the gas collected is read off. After subtracting the small constant of air contained in the tube *B*, the remainder gives by calculation the quantity of urea present in the 5 cc. of liquid examined. Under ordinary circumstances the whole operation may be completed in five or six minutes.

Instead of having the tube *A* graduated into cubic centimeters, it is convenient to have the graduation indicate at once the percentage of urea, as is the case with the tube supplied with Russel & West's ureometer. — *Journal Chem. Soc.*

Fig. 2489.

U-re'thra Di-vul'sor. (*Surgical.*) See DIVULSOR.

U-re'thra In'stru-ments. (*Surgical.*) These are numerous and included under the following heads: —

Applicator.
Catheter.
Dilator.
Divulsor.
Forceps.
Lithotrity instruments.
Ointment bougie.
Porte-caustic.
Searcher.
Sound.
Speculum.
Staff.
Stricture cutter.
Stricture dilator.
Syringe.
Urethrameter.
Urethratome.

Otis's Urethrameter.

U're-thram'e-ter. (*Surgical.*) An instrument for measuring the diameter of the *meatus urinarius*.

Dr. Otis's apparatus, Fig. 2489, consists of a small, straight canula, terminating in a set of fine steel springs hinged upon the canula, and also upon the distal extremity of the instrument, where they unite. At this point a fine rod, running through the canula, is inserted. This rod (which is worked by a screw at the handle of the instrument), when retracted, expands the springs (six in number) into a bulbous shape, from ten to twelve millimeters in circumference when closed, and capable of expansion up to forty-five millimeters.

That of *Dr. Gross* has a pair of expanding arms on the end of a staff, and an index on the handle to show the degree of expansion in *situ*. Fig. 71, Supplement, *Tiemann's* "*Armamentarium Chirurgicum.*"

Dr. Weir's is on the same principle. Fig. 68, *Ibid.*

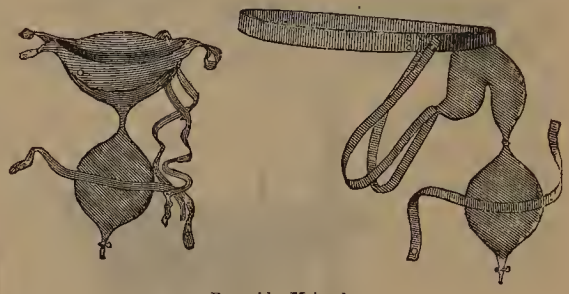
Dr. Otis's has expanding jointed toggle arms. Fig. 94, Part III., *Ibid.*

U're-thro-met'ric Sound. (*Surgical.*) An olivary sound in a canula, the shaft being graduated to measure the length of insertion or of projection of the bulb beyond the end of the canula.

Leonard, Fig. 93, Supplement, *Tiemann's* "*Armamentarium Chirurgicum.*"

U'ri-nal. Figs. 2490 and 2491 show forms of portable urinals for convenience of persons afflicted with incontinence of urine. They are adapted for constant wear on the person, and are made of the best rubber.

Fig. 2490. Fig. 2491.



Portable Urinals.

U'rine Bat'te-ry. (*Electricity.*) The plates are immersed in a trough through which urine flows. Ammonia is the chief excitant.

U'ri-nom'e-ter. (*Surgical.*) Apparatus for making urinary examinations, including —

Balance = 1-50 grain.
Blow-pipe.
Bunsen burner.
Burette, etc.
Filtration apparatus.
Graduated glass.
Hydrometer.
Pipette.
Platinum spur for calculi
Retort stand.
Specific gravity bottle.
Test tubes and stand.
Wash bottles.
Water bath.
Water oven.

See pp. 78-80, Part II., *Tiemann's* "*Armamentarium Chirurgicum.*"

U'su-du'ri-an. A material for packing, made of unvulcanized rubber and other substances. It is a non-conductor, and when subjected to the action of steam it is vulcanized and enabled to resist influences which are usually very destructive of ordinary rubber packing. By the application of naphtha to their surfaces, two pieces of the usudurian may be united, and under pressure become practically one, which is a convenience, as the user is thus enabled to build up any desired thickness of packing.

U'te-rine Ap'pa-ra'tus. (*Surgical.*) This embraces the following: —

Applicator.
Cautery.
Cervix uteri instruments.
Dilator.
Douche.
Dressing instruments.
Ecraseur.
Electrode.
Elevator.
Embryotomy instruments.
Excision instrument.
Forceps.
Injector.
Knife.
Leech.
Ovariotomy instruments.
Placenta instruments
Probe.
Redressor.
Repositor.
Scarifier.
Scissors.

Sector.
Speculum.
Supporter.
Syringe.
Tenaculum.
Tourniquet.
Tumor instruments.
Tupelo dilator.
Uterotome.

See under the respective heads. See also Figs. 6881-6885, p. 2685, "*Mech. Dict.*"

U'trecht Vel'vet. (*Fabric.*) A furniture plush made entirely of mohair, or, in the common qualities, with cotton warp. See MOHAIR.

U-vu'la-tome. (*Surgical.*) A knife for operating on the *uvula*. See TRACHEATOME.

V.

Vac'u-um Brake. (*Railway.*) A system of continuous brakes which is operated by exhausting the air from some appliance under each car by which the pressure of the external air is transmitted to the brake levers and shoes. An ejector on the engine is ordinarily used for exhausting the air, and it is connected with the rest of the train by pipes and flexible hose between the cars.

The vacuum brake is to be distinguished from the air brakes of the Westinghouse and Loughridge class in which the brake-levers are operated by compressed air.

The *Smith* and *Eames* brakes are of the vacuum order.

The former has flexible cylinders beneath each car, connected by pipes and hose with an ejector on the locomotive, which operates to exhaust the air from the cylinders. The latter are collapsible, and the movable head is connected to the brake-levers. See Figs. 649, 650, *Forney's "Car-builder's Dictionary."*

The *Eames* brake is similar in mode of operation. *Ibid.*, Figs. 653, 654.

Vacuum brake, *Eames*.
* "*Iron Age*," xx., Aug. 16, p. 1.
Hardy, Austria.
* "*Engineer*," xlv. 346.
Hardy, Vienna.
* "*Engineer*," xlix. 297.
Smith . . . . . * "*Engineer*," xlii. 451.
Automatic, *Aspinall*, Br. * "*Engineer*," xlviii. 166.
Automatic, self-registering, *Sanders*, Br. . . * "*Engineer*," xlviii. 216.
Automatic, *Sanders*, Br. * "*Engineering*," xxiv. 113.
Continuous, *Sanders*, Br. * "*Engineer*," xliv. 106.
Continuous, automatic, *Eames*, Br. . . . . * "*Engineer*," l. 28.

Vac'u-um Pan. A vessel for evaporating saccharine juices in vacuo.

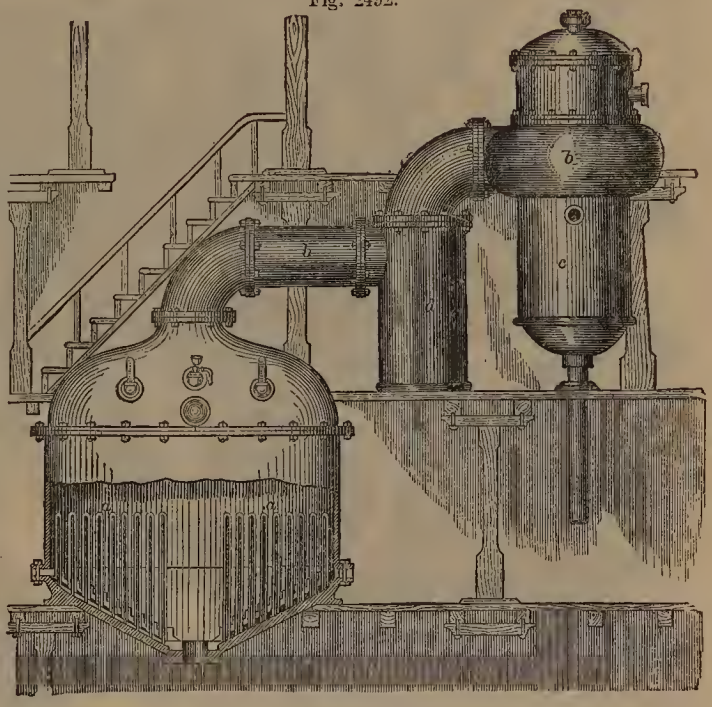
The "drum" pan, so called from its shape, is usually upright, and heated by a series of vertical tubes near the bottom.

In the "Gould" pan, Fig. 2492, the pipe that conveys the vapor to the condenser, passes round the latter, forming an annular space of semi-circular cross-section, joining the body of the condenser, and being continuous with it below and bolted to a flange upon it above.

Water falls upon the perforated reversible spray plate, that has its pivotal axis passing through a stuffing box, and attached to a hand lever, by which the plate is turned to allow the water to alternate to prevent the apertures from becoming clogged. The vacuum pump is connected with the top of the condenser.

The Colwell vacuum pan is elevated on great iron columns three stories high. Inside are four copper serpentines, and into these steam is led. The circulating pump and the centrifugal machines are placed on the first floor. On the second floor is a large receiver which receives the contents of the pan after concentration, in the shape of a dense mass of semi-fluid material, a magma. This goes into the centrifugal machines, which separate the sugar from the molasses. The vacuum pan of Messrs. Colwell and Brother, of New York, is 8′ in diameter, and, in a single operation of

Fig. 2492.



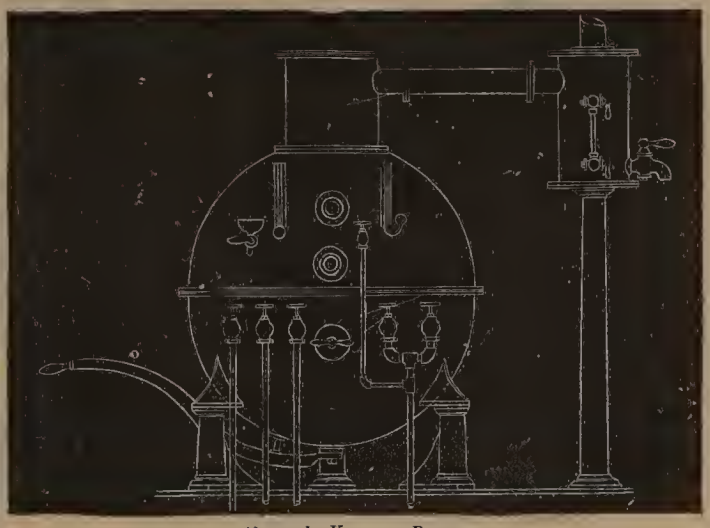
The Gould Vacuum Pan.

three hours in duration, can produce fifteen hogsheads of sugar.

The Alvarado pan, Fig. 2493, is adapted to a factory working up fifty tons of beets per day. It is 6½′ in diameter and is 7′ high. The egress valve is operated by a lever from beneath the pan. A dome on the top is connected by a pipe to the safe, which has a glass gage, and a cock for drawing off the syrup that collects in it.

Two coils of pipe inside the pan heat the syrup and obtain

Fig. 2493.

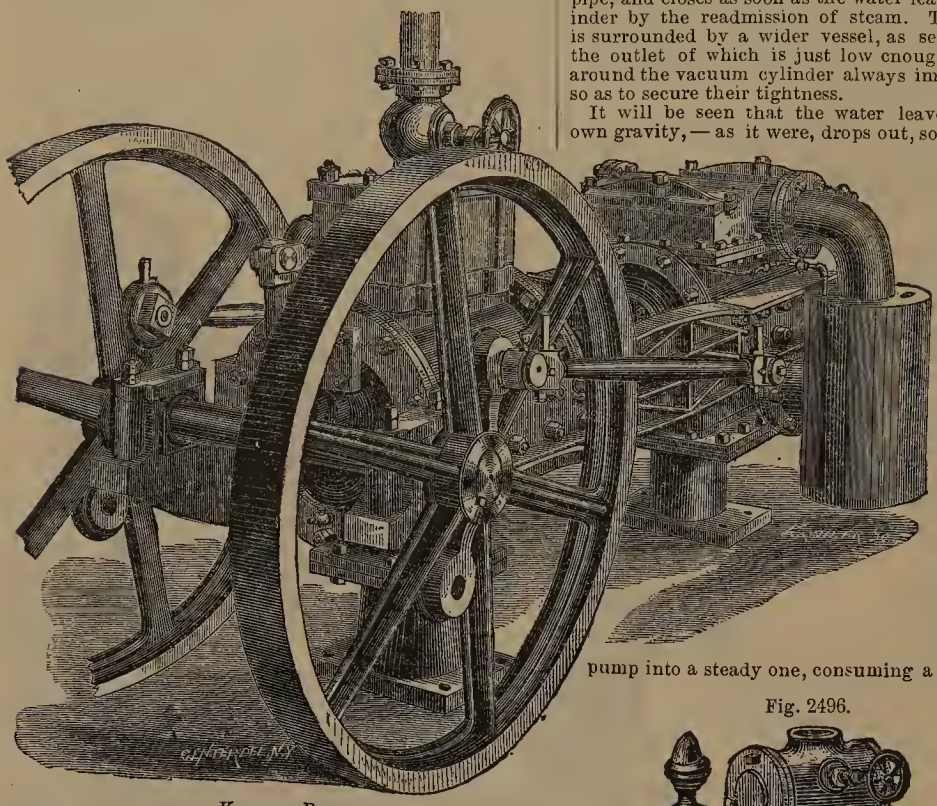


Alvarado Vacuum Pan.

their supply of steam by the pipe connecting with the generator.

Comp. Fivesdelle, Fr. . * "*Engineering*," xxvi. 132.
Deeley & Co. . . . . * "*Scientific American*," xliii. 335.
* "*Manuf. & Builder*," xii. 273.
Immense . . . . . "*Iron Age*," xxi., March 7, p. 7.

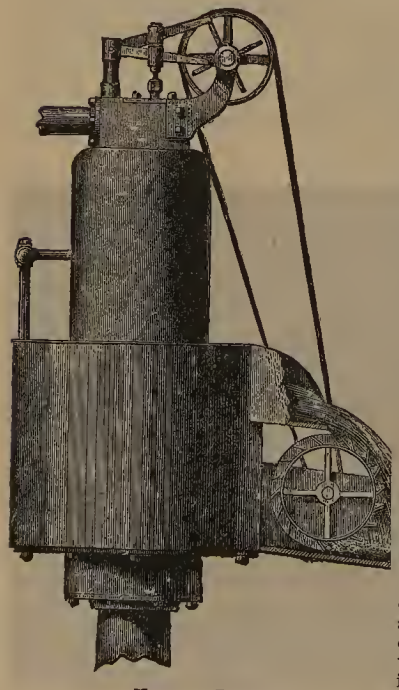
Fig. 2494.



Vacuum Pump.

Vac'u-um Pump. If the exhaust steam of a pumping or other steam engine is allowed to enter a closed vessel, and is there submitted to condensation by cooling, a vacuum will be formed. Such a vacuum may be utilized to raise water, if only the proper secondary appliances are added to make this condensation of the steam the subsequent raising of water, and its discharge and refilling with steam, alternate.

Fig. 2495.



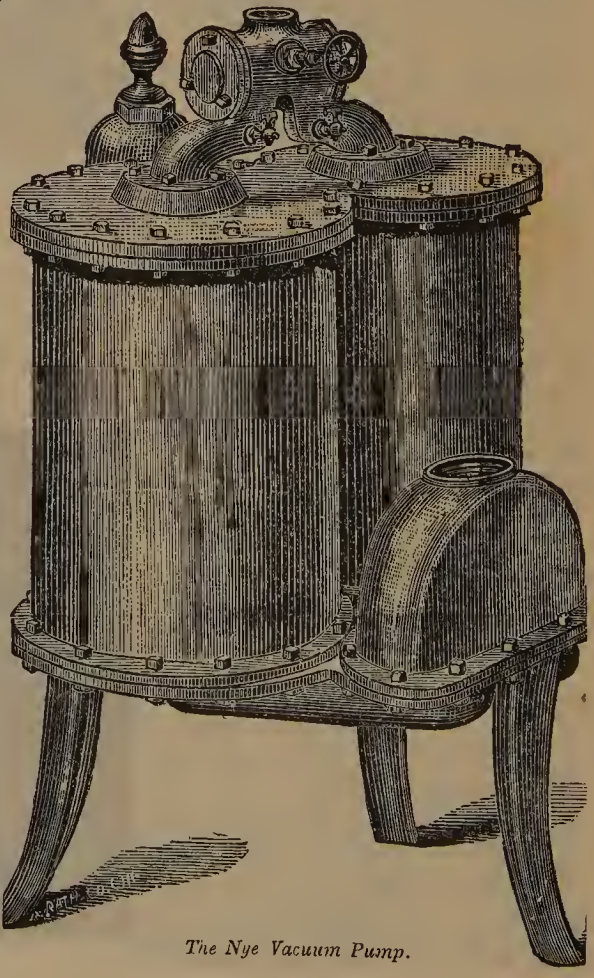
Vacuum Pump.

An ingenious way to effect this alternate action is represented in Fig. 2494, and is the invention of Mr. Wm. Burdon, President of the New York Hydraulic and Drainage Co. Water escaping from the vacuum cylinder is caused to turn a small overshot wheel, which, by means of a belt, is connected with a pulley on top, the revolution of which works the alternate admission of the steam into the vacuum cylinder. This cylinder is surrounded with large valves at its lower end, giving rapid exit to water and closing against its reëntering, while another valve at the top of the suction-pipe and the bottom of the vacuum chamber opens when the vacuum produces suction and draws the water up through the suction-pipe, and closes as soon as the water leaves the vacuum cylinder by the readmission of steam. The vacuum cylinder is surrounded by a wider vessel, as seen in the engraving, the outlet of which is just low enough to keep the valves around the vacuum cylinder always immersed under water, so as to secure their tightness.

It will be seen that the water leaves the pump by its own gravity, — as it were, drops out, so that the steam does not meet with any resistance whatsoever; on the contrary, when it enters it is rather drawn in and acts in this way on the steam-engine from which it is obtained almost like a condenser. The arrangement added to a high-pressure engine changes it practically into something even better than a condensing engine; in fact, into something similar to a compound engine; the steam is first utilized by its pressure and then by its condensation.

In order to change the intermittent action of this vacuum pump into a steady one, consuming a steady stream of ex-

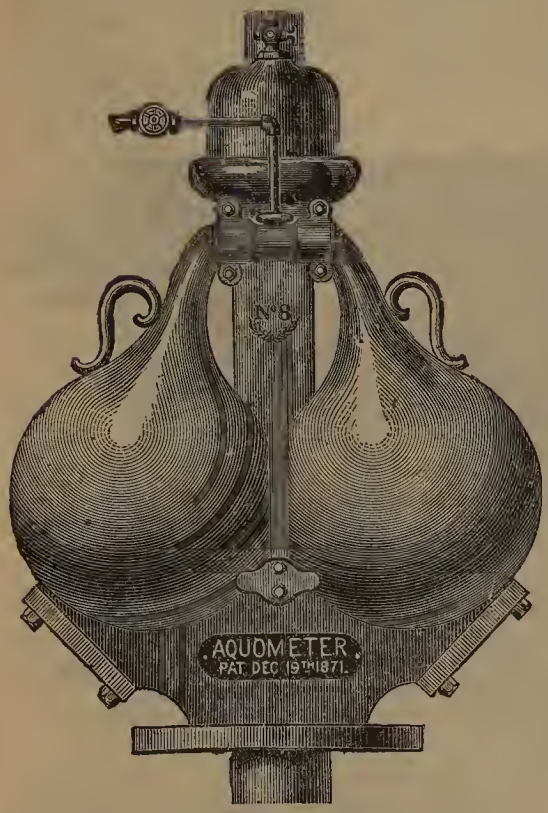
Fig. 2496.



The Nye Vacuum Pump.

haust steam, producing a continuous suction and rise of water and a steady stream of water, two suction pumps may be combined, the steam entering alternately the one and then the other, while this admission may be regulated in the same way as represented in Fig. 2495, or by means of other power, when the pulley is driven by a belt from shafting above.

Fig. 2497.



Vacuum Pump.

The revolution of this pulley opens and shuts the steam-valves alternately, so that the steam entering by the main pipe is in succession first thrown to the right and then to the left vacuum cylinder, so that while in one the steam enters it is being condensed in the other.

There is nothing to prevent multiplying these pumps and connecting them into one system, so as to be able to use all the exhaust steam disposable, when a steady, large stream of water may be obtained raised from a depth equal to that from which any suction pump may raise it by atmospheric pressure.

The "Nye" pump, Fig. 2496, is said to discharge 800 gallons per minute. It consists of two cast-iron cylinders lined with wood, to prevent loss of steam by coming in contact with the metal, the condenser (a plain chamber back of the cylinders), a simple balanced automatic steam valve on top of cylinders, and four valves covering suction and delivery ports.

The aquameter pump, Fig. 2497, has two chambers alternately occupied by water and steam. The steam being admitted by a balanced piston-valve forces the water out, and then condensing, forms a partial vacuum, into which the water rushes under atmospheric pressure.

Blake, * "*Manuf. & Builder*," x. 172
N. Y. Drainage & Hyd. Co., * "*Man. & Builder*," viii. 29, 100.

Vac'u-um Shunt. An electric vacuum shunt of variable resistance was exhibited by Dr. Stone at the meeting of the Physical Society, on June 26, 1880. The variable resistance was formed neither by a set of coils, a platinum-iridium wire, or a tube of water, but by a Torricellian vacuum at the top of a mercury column, the height of which could be increased or diminished at will.

The apparatus consists of an ordinary barometer tube of glass 32″ long, and terminating above in a short vacuum chamber arranged transversely, and closed at either end by adjustable india-rubber stops, through which platinum terminals are passed. The tube is continued beyond this chamber to a stop-cock, by which small quantities of air can be admitted into the vacuum. The foot of the tube is connected by a flexible india-rubber pipe to an open glass cistern, like that of a Frankland gas apparatus. This cistern is nearly filled with mercury, which, on the barometric principle, ascends the tube till the height of the column above the surface level in the cistern just balances the pressure of the atmosphere. The cistern is suspended by a cord over a pulley, and counterweighted so that it can be raised or lowered through the whole 32″. On passing an induction spark through the Torricellian chamber all the discharge is diverted through this shunt. But on admitting a little air by the stop-cock to render the vacuum less perfect, and raising or lowering the cistern, so as to lengthen or shorten the mercury column, the resistance of the vacuum can be increased or diminished within wide limits. In this way, according to Dr. Stone, a point can be found at which the induction spark due to breaking contact is shunted through the vacuum tube, while the weaker discharge due to making contact is arrested. The induction current is thus obtained in a single direction, a matter of some importance in physiological experiments.

Va-len'ci-a. (*Fabric.*) A French dress goods woven on a taffetas loom. It has a silk chappe warp and a combed-wool weft.

Val'en-tine's Knife. A two-bladed knife for making a thin section of a tissue for microscopic purposes at a single stroke.

Val'gus, Tal'i-pes Ap'pa-ra'tus. (*Surgical.*) See CLUB-FOOT APPARATUS.

Valve. A device for regulating the passage of a fluid through a pipe or aperture. See p. 2688, "*Mech. Dict.*"

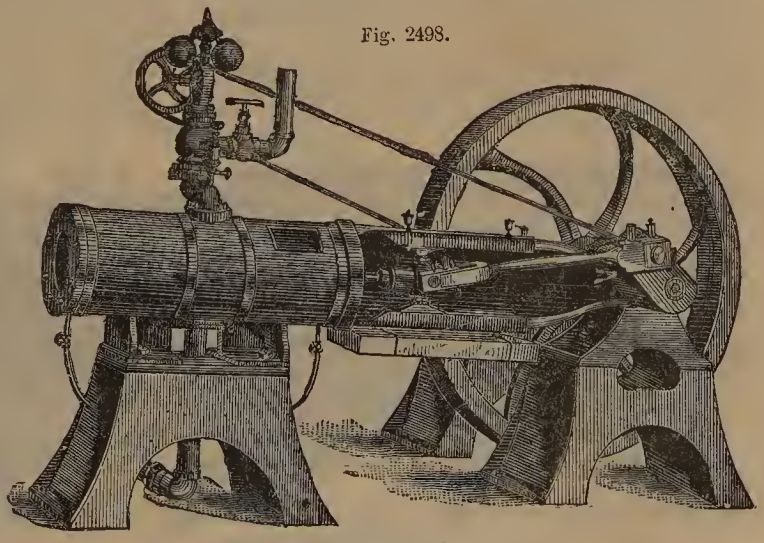
For water mains, *Armstrong*, Austr. . . . * "*Engineering*," xxii. 335.
Manufacture of, *Ludlow* * "*Scientific American*," xli. 79.
Mathewman & Johnson * "*Engineer*," xlii. 298.
Oscillating, *Marigold* . * "*Scientific Amer.*," xxxix. 134.
Water, *Chapman* . . . * "*Scientific Amer.*," xxxix. 389
Valve face planing machine, *Sharpe, Stewart & Co.*, Br. . . . * "*Engineering*," xxvi. 322.

Valve Gear, Cut'-off. A detachable adjustable table or drop-off valve gear.

Valve'less En'gine. The "Wardwell" valveless engine, Fig. 2498, is horizontal, with one end of a girder frame bolted to and supporting the cylinder, and the other the pillow-block.

The cylinder has a bore 8″ × 35″; the stroke is 16″. The

Fig. 2498.



Valveless Engine.

pillow-block brasses have side adjustment by wedges, operated by bolts and nuts, from the top capface. The cross-head has V-shaped bearings, and has a gudgeon which provides journal-bearing for the fork-end of the connecting-rod. The piston-rod passes through the cross-head, in which it has journal-bearing for its semi-rotary motion; a nut and check-nut preventing longitudinal motion or "end-play" in this bearing. The connecting-rod has a strap at each end that is secured to it by a bolt passing through the ties, the key serving merely to adjust the brasses. Inside the outer fork of the connecting-rod is bolted a section of a bevel-wheel, with four teeth, and which gears into a similar but five-toothed section, keyed to the extreme end of the piston-rod. The reciprocation of the piston-rod produces an oscillation of the connecting-rod; but the two rods being geared together, the piston-rod and head are given the reciprocating semi-rotary motion desired.

The piston head is solid, having spring packing rings at each end, and a longitudinal spring-packing piece separating the steam passages. The steam port is in the center of the cylinder, at the top; its dimension is $3'' \times \frac{3}{4}''$. The exhaust port is $3'' \times 1''$, and diametrically opposite. The steam passages in the piston run along the circumferential surface of the piston head in a longitudinal but curved line which keeps the passage open to the cylinder port up to that part of the stroke and rotation when the cut-off is desired. Here the cut-off is effected by turning the passage sharply at right angles and in the direction of the piston rotation, giving the rest of the stroke under expansive steam. The steam-passage, after the abrupt turn mentioned, continues longitudinally to the end of the piston head; and at the end of the stroke is in communication with the exhaust port of the cylinder, and immediately acts as the exhaust passage, a similar or complementary passage alternating with it for steam and exhaust successively.

Van'ner. A separator and dresser for sifting minerals.

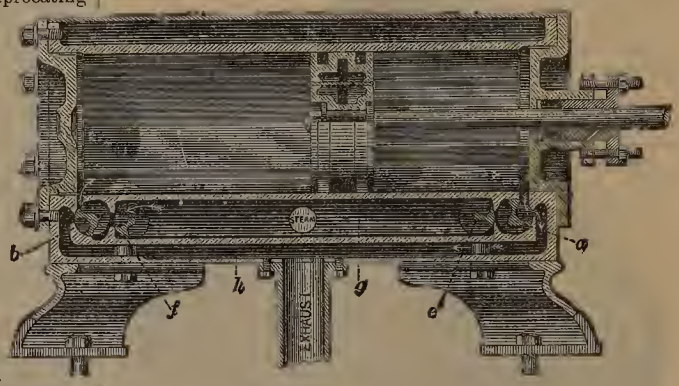
The Cornish vanner is a wide traveling belt of canvas and india-rubber, with a smooth rubber surface and deep flanges on each side, which travels slowly upward, and on the upper end of which the stuff to be dressed is carried by a launder and head. This belt, in addition to its upward motion, has a rapid shaking action imparted by cranks driven from a side-shaft, and the result is that while the waste is washed off the belt, at the bottom the mineral settles upon and adheres to it, and is carried over the upper cylinder and down into a coffer through the water in which the belt passes, and into which all the mineral is washed. The object throughout is, of course, to imitate the vanning action of the miner's shovel, the most efficient separator and dresser known. The machine at West Seton is larger than that put up at New Consols, the belt being 4′ in breadth and its upper surface 12′ in length. The inclination of the belt is 6″ in 1 foot, and the traveling speed about 10′ a minute, while the shakes are going at the rate of about 180 in the same space of time. But the speed, of course, depends upon the character and quality of the stuff. At West Seton the vanner has been tried on the tails of the slimes, and has thoroughly proved its efficiency by taking out all the mineral that is worth anything, that which passes off being worthless and utterly incapable of being treated profitably.

Va'ri-a-ble Cut'-off. One arranged to cut off at different parts of the piston stroke according to the speed of the engine.

In the Wheelock arrangement, Figs. 2499, 2500, the two winged induction and eduction valves *a b* have inclined conical faces, and are fitted rather loosely so as to pack by steam pressure as they wear. They are vibrated, through proper connections, by the rods *c d*, the latter attached to the eccentric. The cut-off valves *e f* have similar faces, and are also rather loosely fitted to insure constant light packing. They are operated by the dash-pot weights through the medium of a series of devices adjustably connected with the governor, so that they may be permitted to remain altogether inactive or arranged to cut off at varying points of the stroke depending on the speed of the engine. *g* is the steam chest and *h* the exhaust chamber, located beneath the cylinder to allow water of condensation to flow away.

Engine, *Porter Allen* . . * "*Engineering*," xxvii. 107, 115.
Fish . . . . . * "*Sc. American*," xxxvi. 166.

Fig. 2500.



Sectional View, showing Valves.

Var'ley Bat'te-ry. (*Electricity.*) A battery in which the entrance of the sulphate of copper into the positive cell is prevented by the substitution of oxide of zinc for the paper partition. Any sulphate of copper entering the mass of oxide of zinc forms sulphate of zinc and deposits black oxide of copper.

Niaudet, American translation, 110.

Var'nish. The name is said to be from Berenice, a port on the Red Sea, 200 miles south of Cossier, established by Ptolemy Philadelphus as the port for landing the Oriental gums, etc., for the overland journey to Coptus on the Nile, 20 miles below Thebes.

The Orient is the home of many of the gums and resins used in the making of varnish, and some of the names have been strangely corrupted.

The *jackass* copal is a very unpoetical rendering of the Arabic *shikasi* (fresh) copal, so called as being *fresh* from the tree, to distinguish it from the half-mineralized copal which is dug out of the ground on the site of extinct copal tree forests.

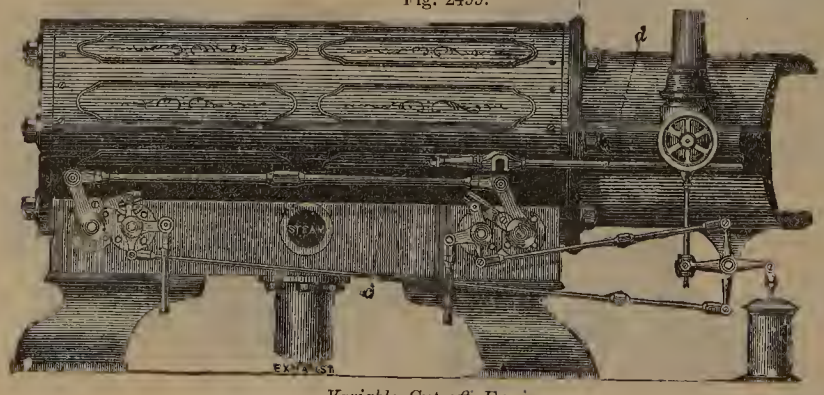
A perfume, *rose mallóes*, the liquid storax of *Liquid-ambar Altingia* is from the Javanese *rasamala*.

Gum Benjamin is from the name *luban djawi*, given to it by the Arab traders, at least as long ago as the fourteenth century.

Camphor: Sanscrit *karpure*; Arabic, *kafur*.

Brazil-wood of the East Indias; *braise*, hot coals, from its color. Since applied to a dye-wood of Brazil, also.

Fig. 2499.



Variable Cut-off Engine.

FOR SILVER WARE.

Gum elemi	30
White amber	45
Charcoal	20
Spirits turpentine . . .	375

Used in a heated state, the metal being also heated.

Mr. F. Thies, of Bissendorf, Germany, claims the following preparation to be a good substitute for varnish. Heat 100 parts of colophonium and 20 parts of crystalized soda with 50 parts of water, and then add 250 parts of water and 25 parts of ammonia. The mass thus obtained is said to be fit for painters' use.

Boiler, *Werner*.
* "*Scientific Amer. Sup.*," 2715.

For foundry patterns . "*Scientific American Sup.*," 2440.
Making . . . . . * "*Manufact. & Builder*," ix. 256.
Removing . . . . . "*Scientific American Sup.*," 1481.
Varnishing, Japanese . "*Scientific Amer.*," xxxvii. 297.

Vas'e-line. A product of petroleum. Petroleum jelly. The heavy residuum of distillation is filtered through animal charcoal, which deodorizes and decolorizes the viscid hydro-carbon, and gives the familiar, bland, neutral product known as vaseline. This forms a vehicle for medicaments of various kinds; with 3 per cent. of carbolic acid it is a valuable antiseptic, and cerate for eczema.

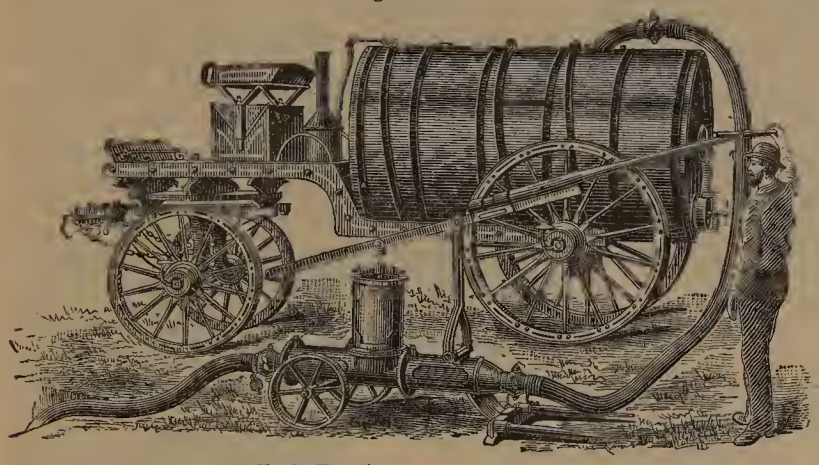
Vat. (*Leather.*) A large rectangular pit used in tanning.

Vat Net. Used as a strainer over a tub or tank.

Vault Emp'ti-er. A combined pump with deodorizing apparatus for emptying vaults, cesspools, etc.

The deodorizing can in front of the tank contains a chemical mixture through which the foul air displaced from the tank must pass in its escape. It is claimed that it is thoroughly disinfected, destroying all offensive odor. See Fig. 2501.

Fig. 2501.

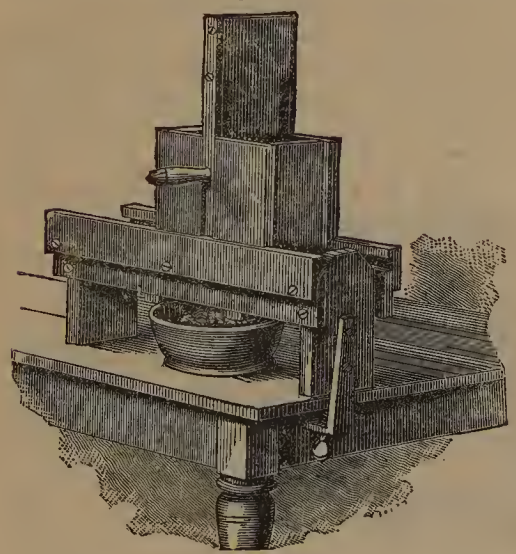


Vault Emptier.

Veg'e-ta-ble Cut'ter. A device for slicing vegetables for cooking or table use.

Fig. 2502 has a two-edged stationary knife, with the bottom of the laterally sliding box in two sections, each end rising alternately, being lifted by cams beneath according as it is working towards the knife or away from it, so as to present the material to the cutting surface of the knife.

Fig. 2502.



Vegetable Cutter.

Veg'e-ta-line. A substitute for ivory, coral, leather, caoutchouc, etc., lately patented in England under the name of *Vegetaline*, is prepared as follows: Cellulose (woody fiber), from any source whatever, is treated with sulphuric acid of 58° B. (= sp. grav. 1.676) at 15° C. (= 59 Fah.), then washed with water to remove excess of acid, dried and converted into a fine powder. This is mixed with resin-soap, in a mortar, and the soda of the soap is removed by treatment with sulphate of aluminium. The mass is now collected, dried again, and pressed into cakes by hydraulic pressure. These cakes are then cut into thin plates, which are shaped by again subjecting them to pressure. By adding castor oil or glycerine to the mass before pressure, the product may be made transparent. Colors may be imparted by the use of vegetable coloring agents. Facts respecting the strength and elasticity of this product are wanting.

Ve'hi-cles. See under the following heads: —

Ambulance.
Ambulance stretcher.
Army wagon.
Gun barrow.
Gun carriage.
Mortar carriage.
Mortar truck.
Shell truck.
Sling wagon.
Stretcher.

Ve'hi-cles and Me-nage'. See under the following heads, (for irons, see HARDWARE): —

Aparejo.
Axle.
Baggage barrow.
Baggage truck.
Bag-holding truck
Barrow.
Bicycle.
Block truck.
Bloom truck.
Box barrow.
Box truck.
Buck-board.
Cabresto.
Carboy barrow.
Cart.
Charging barrow.
Chock-block.
Coach.
Coal barrow.
Coal car.
Coke barrow.
Dirt barrow.
Dirt cart.
Dog velocipede.
Dry-goods truck.
Dumping barrow.
Equalizer.
Equibus.
Express wagon.
Food car.
Garden barrow.
Hand cart.
Hand truck.
Hook and ladder truck
Hose carriage.
Hose cart.
Hose reel.
Hotel coach.
Hub.
Iron barrow.
Ladder truck.
Liquid manure cart.
Litter.
Mail coach.
Mortar barrow.
Off-bearing barrow.
Omnibus.
Ox cart.
Pedomotor.
Pig-iron barrow.
Platform truck.
Pump barrow.
Pump cart.
Quadricycle.
Railway barrow.
Roller skates.
Rubber wheel.
Runner.
Sack barrow.
Sack holder.
Sack truck.
Saddle.
Seal spring.
Sewer-shaft wagon.
Sprinkling cart.
Steam trolly.
Stone barrow.
Stone cart.
Stone truck.
Stove truck.
Street sweeper.
Sulky.
Sweeping machine.
Tank barrow.
Timber cart.
Toboggin.
Transplanting wagon.
Tricycle.
Trolly.
Truck.
Tub barrow.
Two-wheel barrow.
Unicycle.
Van.
Velocipede.
Wagon.
Wagon lock.
Wagon seat.

Warehouse truck.	Wharf barrow.
Water barrel truck.	Wheel.
Water cart.	Wheelbarrow.
Watering cart.	Wood barrow.

Vein. (*Mining.*) Aggregation of mineral matter in fissures of rock.

Ve-lo-cim'e-ter. An apparatus for measuring the velocity of projectiles in guns.

The methods that have been tried for ascertaining the law of motion of a projectile in the bore of a gun (with a view to finding the law of pressures developed) give only a small number of points of the curve of spaces traversed in given times, and they involve perforation or other injury to the walls of the gun, so that they are applicable only to large pieces.

A new and ingenious method, advantageous in these respects, has been contrived by M. Seibert. In the axis of a cylindrical hollow projectile he fixes a metallic rod of square section, which serves as guide to a movable mass. This mass, or runner, carries a small tuning-fork, the prongs of which terminate in two small metallic feathers, which make undulatory traces on one of the faces of the rod (blackened for this purpose with smoke) as the runner is displaced along the rod. The runner, it will be understood, is situated at first in the front part of the projectile, and while the latter is driven forward remains in place, the rod of the projectile moving through it. The escape of a small wedge between the prongs of the fork at the moment of commencing motion sets the fork in vibration. It can be easily shown that, owing to the very high speed imparted to the projectile, the displacement in space of the inert mass, through friction and passive resistances, which tend to carry it forward with the projectile, is such as may be quite neglected. So that the relative motion of the mass recorded by the tuning-fork may be considered exactly equal and opposite to the motion of the projectile. A study of the curves produced guide to the laws of the motion and of the pressures developed by the charge. Evidently the motion of a projectile, as it buries itself in sand or other resistant medium, may be similarly determined.

Also used to measure the recoil of guns during the first instant after the charge is fired. See TACHOMETER.

For ordnance, *Sebert* . . "*Van Nostrand's Mag.*," xxi. 171.
Pitot's tube for gaging * "*Van Nostrand's Mag.*," xviii. streams, *Robinson* . . 255.

Ve-loc'i-pede. Velocipede is a generic name, of French origin, applied to that class of carriages propelled by the feet of the rider, of whatever construction or by whatever mechanical means the power is communicated, so as to drive the vehicle. Less strictly, it has been applied to vehicles propelled by the hands only, and guided by the feet.

The term vélocipède is found in French patents early in the century, and the class of carriages to which it was applied is found to be described and illustrated in the books and the patent records for more than a hundred years past.

Velocipedes, like wagons, have been constructed with one, two, three, or four wheels, and sometimes with greater number. One-wheeled velocipedes, or monocycles, have been constructed in a variety of ways; sometimes so that the rider should be seated above the wheels, but more often that he should be seated inside the wheel, and so as to be propelled sometimes by the hands, and sometimes by the feet. They have never in any form been made a practical success, and their use has been little attempted except for purposes of exhibition.

Scuri, the Italian gymnast, has been more successful with a machine patented by him, consisting of one wheel, axled in a fork or perpendicular frame, and foot-cranks attached to the axle, a handle rod upon the upper part of the fork or perpendicular frame some distance above the wheel, and a saddle attached to a projection from the frame, but with no other supporting or steadying part of the machine touching the floor than the tire on the one wheel.

Two-wheeled velocipedes were made as early as 1816, the first one of which we have any account being attributed to the Baron Von Drais, of Manheim, which had its two wheels in the same plane, one before the other, and was patented in France, and with some improvements patented in England by Denis Johnson, in 1818, under the name of "Pedestrian Curricle." This form of velocipede was patented first in France by Louis-Joseph Dineur, and in the patent it was simply called a velocipede. It acquired the name, however, of *célérifère* and *draisina*, and *draisienne*. This machine was improved from time to time in England, where it obtained the name of dandy horse, and sometimes of hobby horse. In 1821 it was modified in construction by Gompertz, and a rack and pinion attachment, for aid by the hands in propulsion, applied to the front wheel.

In 1819, a United States patent was granted to William K. Clarkson for an improvement "in the velocipede." In all these two-wheeled velocipedes, however, the propulsion was mainly by the thrust of the feet alternately upon the ground as the rider sat astride the horizontal bar or perch; and it was not until 1862 or 1863 that any mechanical means of propulsion was applied to this arrangement of two wheels in the same plane, by which the rider was enabled to take his feet off the ground, and still propel and guide his vehicle. For later developments see BICYCLE.

Two-wheeled velocipedes have also been constructed with the wheels abreast, and considerable success has been attained in the use of this by foot driving mechanism, particularly in the form known as the "Otto," in England. The forms constructed and patented in the United States have differed somewhat in details of construction from that which has achieved some success in England; but nowhere has this form yet become of any extended use or comparative value.

Three-wheeled velocipedes were constructed early in the century, and as early as 1828 were given the more specific name of tricycle. This variety of velocipede, offering as it does by reason of its three points of support, the greatest steadiness of base with least resistance of roadway, and the lightest construction consistent with stability of base, has been constructed with great variety of detail, and become very much specialized, and widely used. See TRICYCLE.

Velocipedes of four wheels have frequently been termed *quadrocycles*, and though at different times and in different countries they have been made in considerable number, they have not been found comparatively practicable as yet, the greater weight, friction, road obstruction, and air resistance, making them less desirable than the bicycle or tricycle.

Velocipedes constructed with more than four wheels have been interesting chiefly for their phenomenal or ingenious construction.

The term velocipede, and the names marine velocipede, water velocipede, etc., have been applied to machines for travel by foot propulsion on the water as well, with various details of construction by means of which the rider was enabled to propel himself; sometimes with paddle wheels, and sometimes with screw or other propellers acting upon the water. The latest and most successful of these has by misnomer been called "marine bicycle," and is at present in considerable use in the United States. It consists of two floats, 4′ or 5′ apart and 20′ in length, connected by bars and crank axle, with pedals for the feet of the rider, and connecting mechanism operating a screw propeller, and a rudder operated by steering bar, held and worked after the manner of the steering mechanism of a bicycle.

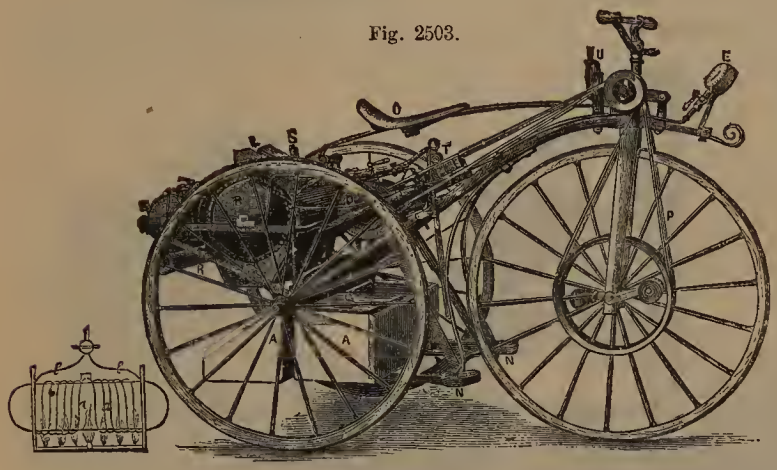
See BICYCLE and WHEEL.

Aquatic, *Jobert* . . . * "*Scientific American Sup*," 128.
Engl. . . . . * "*Scientific American Sup.*," 731.
Ice, *Arnao* . . . . . * "*Scientific Amer.*," xxxv. 325.
Grant . . . . . * "*Scientific American Sup.*," 128.
Propeller, *Zoebl* . . . * "*Scientific American Sup.*," 2525.
Sled, *Story* . . . . . * "*Scientific American Sup.*," 128.
Tricycle, *Ruggles* . . * "*Scientific American*," xli. 338.

Ve-loc'i-pede, Steam. At the recent Industrial Exhibition at the Champs Elysées, Paris, M. Perreaux, of Orne, exhibited a steam velocipede, which is illustrated herewith. Fig. 2503.

The generator, the fireplace, and the motor are arranged behind the saddle of the velocipede, after the manner of the portmanteau of a horseman. Chains or belts transmit motion from the engine to the wheels. All the parts are small, well put together, and very compact. The small tubular boiler is cylindrical and has a capacity of about three quarts; and at the sides there are two receptacles containing a sufficient supply of water to last during a journey of two to three hours. The piston of the engine is about 1″ in diameter and has a 3″ stroke. The whole engine is a mere plaything, and yet, with a pressure of 3½ atmospheres, it has sufficient power to drive the velocipede at a speed of from 15 to 18 miles per hour. The fireplace which heats the boiler is an ingenious novelty, and consists of a small gasometer fed by wood spirit. The vapor of the alcohol issues through holes, and gives a flame endowed with great calorific power. The fire is lighted at will, and in a few minutes steam is up. A method is provided for regulating the escape of the alcohol vapor, and consequently the intensity of the heat. Externally the boiler is furnished with two tubes rolled in the form of a spiral, so that the steam which is produced circulates through these continuously, and is exposed directly to the fire before entering the motor. The steam being superheated, no water is carried over with it. With a speed of 18 miles an hour, the cost of alcohol consumed is from 40 to 60 cents (this calculation, of course, for France). This is certainly not very economical, but it is very pleasant to have a horse under control which eats only when he works.

Fig. 2503.



Steam Velocipede.

Ve-lom'e-ter. A name given by the inventor, Mr. Durham, of Barnet, England, to a governor for marine propeller engines, to prevent racing of the screw.

"*Engineer*" . . . . . * xlvi. 190.

Ve-lon-tine'. (*Fabric.*) A corded French fabric, with fancy wool warp and merino wool weft.

Ve-lours'. (*Fabric.*) A French goods, all wool.

Vel'vet. (*Fabric.*) Old English *velouette*, from the Italian *vellute*, fleecy, nappy, and Latin *vellus*, a fleece.

Ve-neer'. A thin slip of wood, ivory, stone, etc., cemented to the face of some other material to form an ornamental finish thereto.

Celluloid veneers are made by applying a coating of the celluloid, colored, to imitate any desired wood or metal.

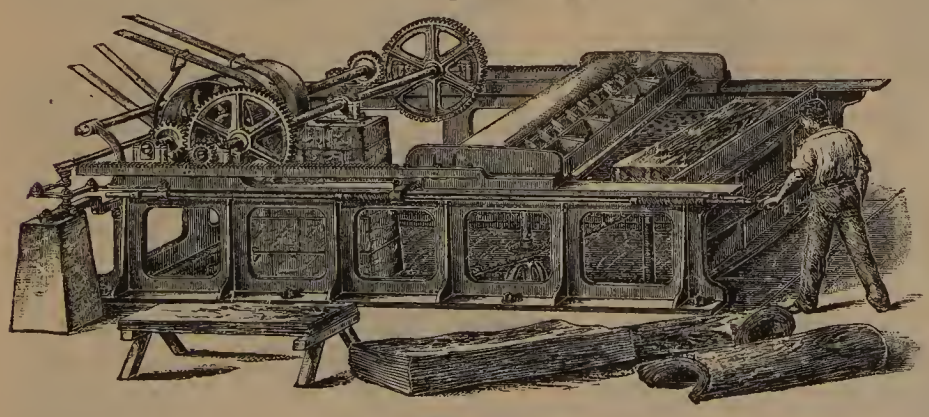
Veneers are cut in two ways, by sawing, and by what is termed a slicing-machine, which is fitted with a sliding knife-block and a thin knife and back iron.

Ve-neer' Cut'ter. The cutter, Fig. 2504, is a slicing machine, and is fitted with a sliding knife-block, and a thin knife, and back-iron, and is used for cutting up blocks 5′, 7′ 8″, and 10′ wide.

The cutter is placed obliquely, so as to lessen the shock that might otherwise displace the wood. The thin knife with back iron does away with the special machine for sharpening, that is usually necessary. When the knife rest is unscrewed from the saddle care should be taken to keep the three pieces, the knife-rest, knife, and back iron together.

In machines with connecting-rod motion for blocks 3′ 3″ the knife is square across the machine or under; so that the fiber is cut along its whole length at once, which is very necessary for some kinds of wood.

Fig. 2504.



Veneer Cutter.

In the larger machines the cutter is placed obliquely so as to diminish the shock, which might displace the wood, but in these machines the workman often places the block parallel to the cutter.

The thin knife with back iron does away with the special machine for sharpening, which is usually necessary.

The wood should first be steamed and the workman should know how to set it according to the grain, to sharpen his knife according to the kind of wood to be cut, and should also watch it drying very closely.

Veneer machines cut from 10 to 15 veneers per minute and from 100 to 150 to the inch, whereas the sawing-machine will not cut more than from 20 to 25.

We allow that for very perfect veneers sawing is better, but for work of usual quality these machines answer admirably. The power required is about 4 horse-power for the large machine; the smaller one can be driven by hand-power.

These machines are also used for cutting veneers up to 4 or 5 mm., and work very well.

Manufacturers of small boxes, etc., profit immensely by their use. In a day of 10 hours, and with horse-power, such a machine will turn-out 3,000 sheets, 4 mm. thick, 16″ long, by 10¾″ broad.

These veneers are cut so cleanly that for common work polishing is quite unnecessary.

The brick palaces of Assyria, Kouyunjik, for instance, were veneered with slabs of coarse alabaster or gypsum held in place by cramps and plugs of metal or wood.

Each slab usually bore upon its back an inscription recording the name, title, and descent of the king forming the same.

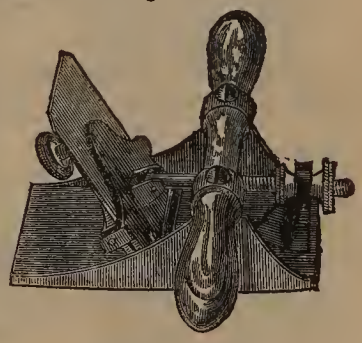
Fig. 2506 is Arbey's horizontal reciprocating saw with a single blade for cutting veneers and thin woods of valuable timber. Has a rising face carriage with automatic intermittent feed.

See VENEER SAW, p. 2702, "*Mech. Dict.*"

Cutter, *Read* . . . . . * "*Manuf. & Builder*," ix. 222.
Seasoner, *Read* . . . . . * "*Manuf. & Builder*," ix. 223.

Ve-neer' Scra'per. Bailey's scraper or plane, Fig. 2505, is an adjustable tool for dressing veneer.

Fig. 2505.



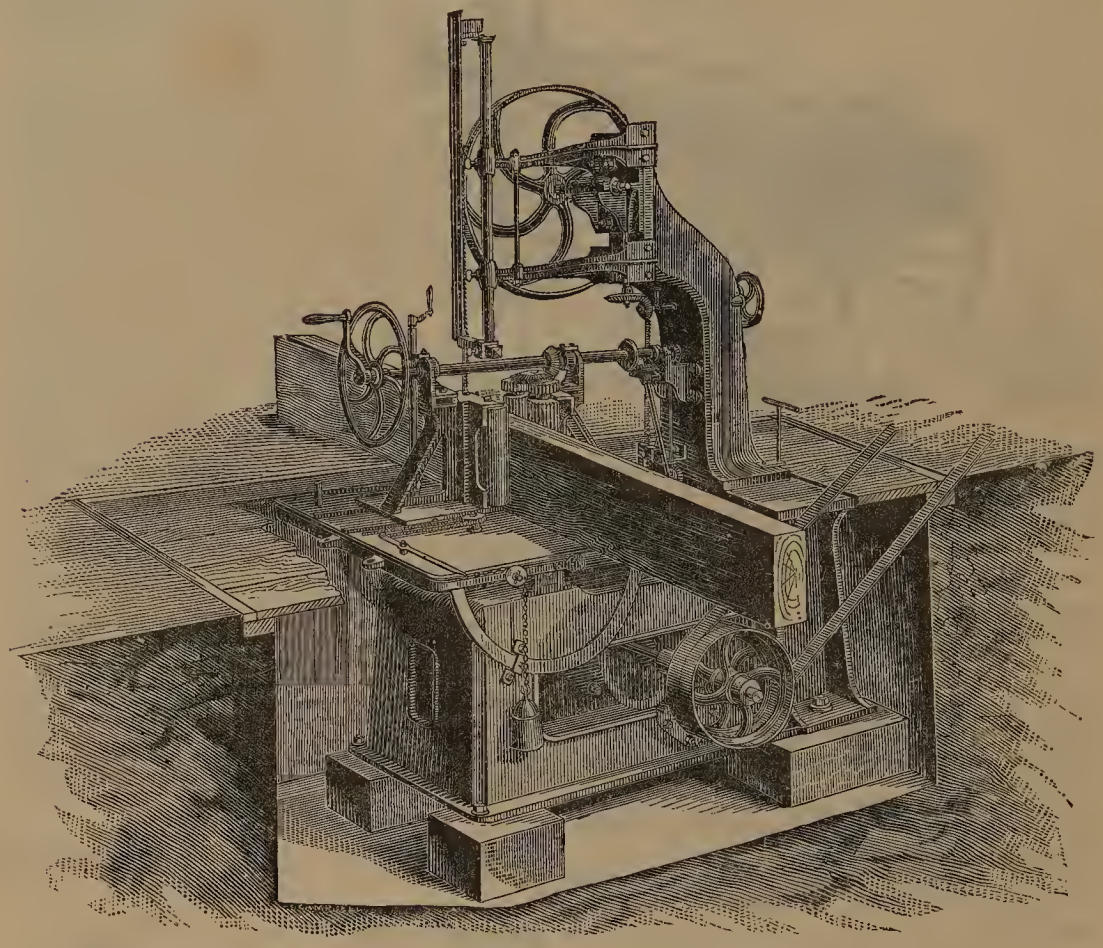
Veneer Scraper.

Vent. Love's liquid vent, Fig. 2507, is a combined gimlet, tubulated vent, and sample pump. It is so operated that as the gimlet opens a passage through the barrel a vent is opened to the plunger that works in the hollow stem of the gimlet, and a sample is drawn from the barrel through the hollow T of the handle.

A spiral spring within gradually stays the piston at the termination of its plunge, the liquid enters the tube above the plunger and on the removal of the thumb the spring lifts the plunger and discharges the liquid through the tube.

The instrument is transferable into a siphon by detaching

Fig. 2506.



Veneer Saw.

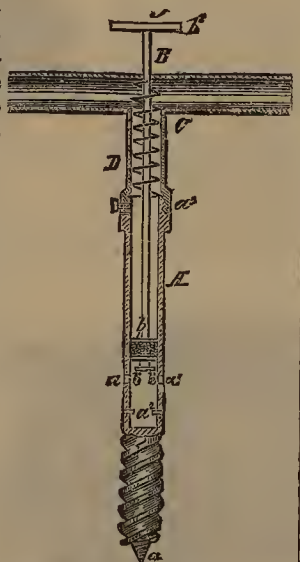
the upper cross-tube and attaching a siphon tube for the passage of the liquid from one barrel to the other. See also VENT FAUCET, p. 2703, "*Mech. Dict.*"

Ven'ti-la'ting Saw. One with the web perforated in numerous places, to allow circulation of air to keep the saw from heating and to admit saw-dust, and thus prevent friction of the saw in the kerf. — *Hoe.*

Ven'ti-la'tion. An elaborate treatise, with illustrations, on ventilation of theaters, hospitals, schools, and public buildings is in *Laboulaye's "Dict. des Arts et Manufactures,"* article "*Ventilation,*" vol. iii., ed. 1877.

Butler's "Ventilation of Buildings." Illustrated.
Atkinson's "Friction of Air in Mines."
Rafter's "Mechanics of Ventilation."
Schumann's "Heating and Ventilation."

Fig. 2507.



Love's Liquid Vent.

Armstrong's "Chimneys for Furnaces," etc.
Tomlinson's "Warming and Ventilation."
Walker's "Useful Hints on Ventilation." Explanatory of its leading principles, and designed to facilitate their application to all kinds of buildings.

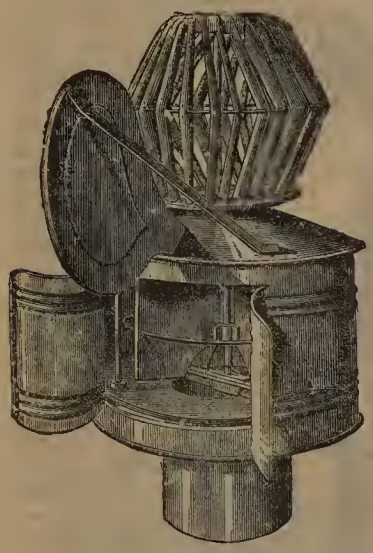
Ventilating blower.
Root . . . . . * "*Scientific Amer.,*" xxxvii 243.
Chimney, *Hinckley* . * "*Scientific Amer.,*" xxxviii. 210.
Cowl, *Banner*, Br. . . * "*Engineer,*" xli. 51.
Bohn, Br. . . * "*Engineer,*" xli. 98.
Engine, mine, *Soc. de Couillet*, Fr. . . . * "*Engineering,*" xxviii. 354.
Fan, *Pelzer*, Ger. . . * "*Engineer,*" l. 153.
Fan engine, *Sacre Madame Colliery*, Fr. . . . . * "*Engineer,*" xlvi. 372.
Rooms, *Dodge* . . . "*Scientific Amer.,*" xxxvii. 321.
Soil pipes, *Banner* . . "*Scientific American Sup.,*" 884.
Ventilation, Hoosac Tunnel, *Doane* . . * "*Van Nostrand's Mag.,*" xvi., 359.
Methods of, *Pfeiffer* . "*Scientific American Sup.,*" 970.
Mine . . . . . "*Scientific American,*" xxxv. 343.
Apparatus, on (6 figs.) Br. . . . * "*Engineer,*" xliv. 332.
Of Madison Square Theater, New York *Hogg* . . . . . * "*Scientific American Sup.,*" 3981.
Coal mines, *Andre* . "*Van Nostrand's Mag.,*" xix. 369.
Schools, *Winsor* . . "*Scientific American Sup.,*" 1556.
Ships . . . . . "*Scientific American,*" xxxiv. 149.
Ship board . . . * "*Engineering,*" xxi. 327.
Railway tunnels . . "*Scientific American,*" xxv. 154.
System of, *Green* . . * "*Scientific American,*" xlii. 86.
Ventilator, mine "Champion" . . . . * "*Iron Age,*" xviii., Nov. 2, p. 1.
Chilton Colliery, Br. . * "*Engineering,*" xxiii. 468.
High Blantyre Colliery, *Stevenson* . * "*Engineering,*" xxvii. 177.
Thwaites & Carbutt, Br. . . . . * "*Engineer,*" xliii. 412.
And engine, *Liége* . . * "*Engineering,*" xxii. 275.

Ven'ti-la'tor. Fig. 2508 represents Gen. Billings's wing fan ventilator.

The ventilator shaft used in connection with this device is enlarged as it extends upward, so that each successive story

of a building may discharge into it without interfering with the proper ventilation of the lower stories. The cowl into which the ventilating shaft discharges is large and nicely pivoted, so that it turns easily with the wind. Its flaring mouth gives it peculiar advantages over the ordinary form of cowl, so that this of itself is a very efficient ventilator; but the chief merit of this device lies in the arrangement of the fan and its propelling wind wheel seen at the top of the cowl.

Fig. 2508.



Wing Fan Ventilator.

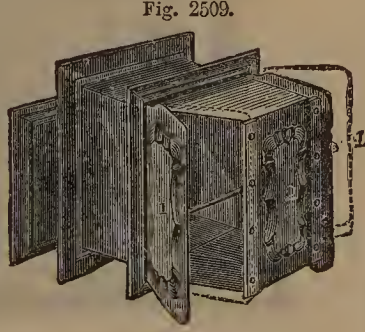
All the parts are made to work very freely and with but little friction. The fans are arranged so as to swing around the inner periphery of the casing, leaving an undisturbed central core, while the enlarged hood and vertical position of the fans offer no resistance whatever to the upward current of air in case the fan should not be in motion. In motion they force the air out through the lateral opening, thus producing a vacuum, aiding the natural draught or creating one where there is none.

With the wing fan ventilator it is found after many tests that when the wind is not strong enough to run the fan, the peculiar form of the cowl, its enlarged size, and prompt action in shifting itself to windward, will give a regular current of from 100′ to 200′ per minute; while with a fair to brisk wind to run the fan the velocity will go up to 300′ and 400′, while with a strong wind it often records over 500′, and has in several cases reached over 600′ per minute. Six tests made November 20, 1879, at St. Denis Hotel, where there is a 24″ shaft capped with a wing ventilator, showed an average of 438′, being an actual exhaust of fully 100,000 cubic feet of foul air per hour. December 22, 1879, in public school branch of No. 15, Brooklyn, six tests showed a current of from 225′ to 357′ per minute, with 8 12″ pipes leading into two large pipes of 24″ each, showing an exhaust of over 146,000 cubic feet per hour, with only a light wind and no fires. Later in the same day the one in Brooklyn "*Eagle*" building showed a current from 230′ to 270′ per minute. November 20, 1879, the Irving House, where there are two of these ventilators, one over each tier of water-closets, gave a current of 525′, there being a good breeze.

Ventilator, *Murphy* . . * "*Eng & Min. Jour.*," xxii. 219.
Centrifugal screw, *Petry & Hecking*, Ger. . . . . * "*Engineering*," xxx. 123.
Pelzer . . . . . * "*Scientific American Sup.*," 3932.
For chemical works, *Hall*, Br. . . . * "*Engineer*," xliv. 50.
Rotary, *Bracher* . . * "*Iron Age*," xxi., Jan. 24, p. 3.
Self-acting, *Gilmore & Clarke*, Br. . . . * "*Engineering*," xxix. 264.
Window, *Sayers* . . * "*Scientific American*," xliii. 274.
Frame, *Sayers* . . * "*Manuf. & Builder*," xii. 139.
Wall and cowl, on (16 figs.), *Trewman* * "*Engineer*," xli. 365.

Ven'ti-la'tor De-flec'tor. On railway cars; a window so hung as to draw the air to or from the inside according to its angular position relatively to the line of motion and to the car. See Fig 2509.

Fig. 2509.



Ventilator Deflector.

Ven'ti-la'tor Hood. A shield over the outside of a ventilator to prevent the entrance of sparks, cinders, rain, or snow. It is sometimes intended to direct the current of air either into or out of the car.

Ver'meil. Silver-gilt.

Ver-nier' Scale Sight. (*Rifle.*) A hind sight with a vernier scale for accurate adjustment. The peep-sight is elevated or depressed by a screw; the scale on the bar of the sight being slotted.

Ver'tic-al Boil'er. A convenient form of steam boiler occupying but small space and well adapted for those of moderate size. The cylindrical shells are now rolled without longitudinal joints, which adds to the neatness of appearance, avoids to that extent the grooving and corrosion which always begin at the joints, and is convenient for fixing the mountings.

There are many forms: Multiflue, multitube, hanging tube, cross tube, spiral tube, etc.

Fig. 2510.

Vertical Boiler.

Fig. 2510 is a plain form without longitudinal rivet joints either on the shell or fire-box, the boiler space being all around the furnace and flue. The flame space is crossed by two large tubes of 6″ or 8″ diameter, one of which is shown in cross and the other in longitudinal section. A manhole is shown in front and mud hole at one side; on the other side is a cover and bridge for the hole by which the flue is reached to remove scale.

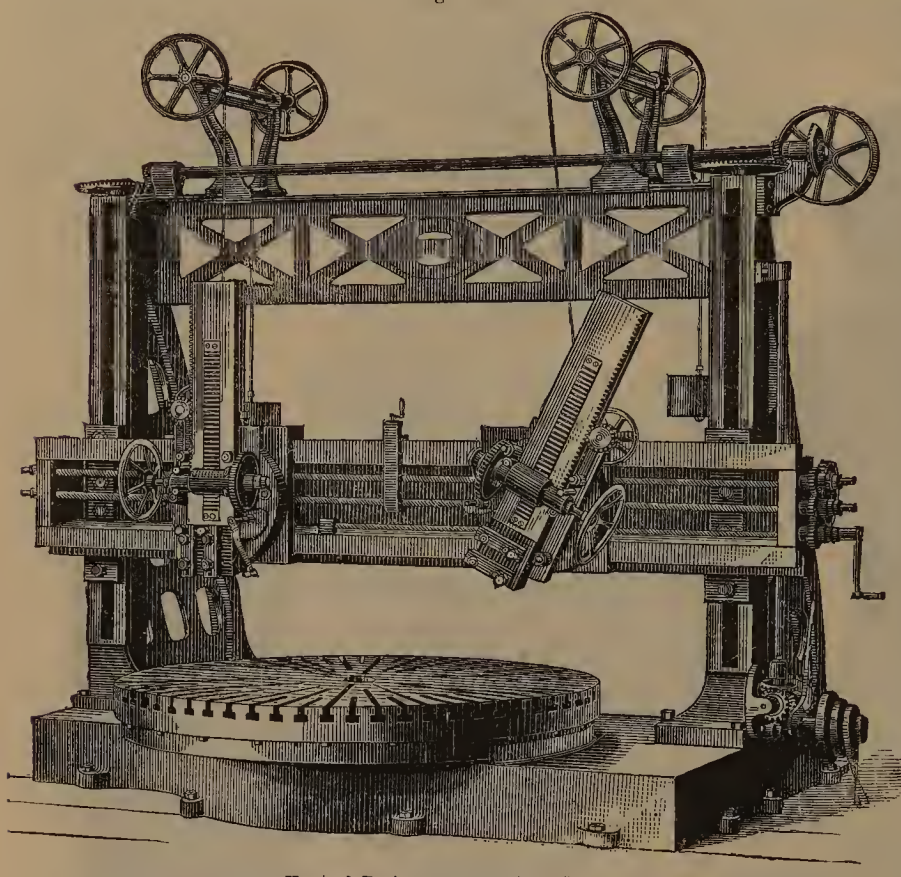
Blake, Br. . . . . * "*Engineering*," xxix. 147.
* "*Engineer*," xlix. 447.
Cochran, Br. . . . . * "*Engineer*," xlv. 288.
* "*Engineering*," xxvi. 303.
Talbot, Br. . . . . * "*Engineering*," xxix. 108.
Proctor & Wallis, Br. . . . * "*Engineer*," xlviii. 306.
Double-chambered. *Smith*, Br. . . . . * "*Engineering*," xxviii. 69.
Tubulous boiler, *Smith*, Br. . * "*Engineer*," xlviii. 24.
Tubular flue boiler, N. Y. Safety Steam Power Co. . * "*Engineer*," xli. 209.

Ver'tic-al Bor'ing and Turn'ing Machine'. The Beuvant machine, Fig. 2511, swings 12′ diameter and 6′ high. The face plate is driven by spur pinion with 20 changes of speed, and is supported upon a spindle, with step to sustain the weight, and adjusted vertically and laterally, giving steadiness to large work.

The tool slide has 30″ vertical or angular traverse, rapid hand-motion, and counterbalance carried on frame of the machine. There is self-acting feed at all angles and in either direction, with four changes. The cross-head is raised and lowered by power.

The French vertical boring machines have their special uses with different kinds of borers and slides. They are used for routing sabots and gun stocks. The rounded ends of the mortise are squared out by a double chisel worked by a lever. The French use a simple hollow bit, like a pod bit, and run the mandrel 2,000 revolutions per minute.

Fig. 2511.



Vertical Boring and Turning Machine.

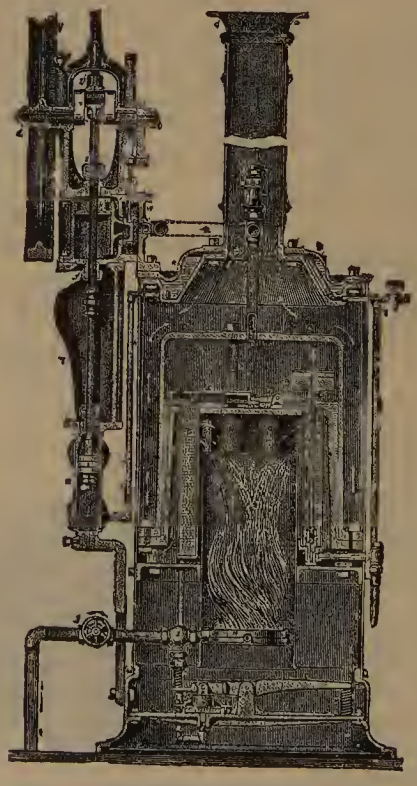
work. The cone has 4 speeds for 2″ belts, and gives a wide range in speed and power; the spindle is driven by cut bevel gear (2 to 1); the arm carrying the belt shifter can be revolved around the driving shaft to suit the direction of the belt; the table arm has a lift of 20″, and can be swung entirely around the column. The base is provided with T slots for securing work, and the table is raised and lowered by a worm and oblique rack, enabling the operator to manipulate the table when it is loaded. By an arrangement of sheaves the spindle and lower stock is balanced by a single weight; the balance weight plays within the hollow column. See UPRIGHT DRILL.

Woodward.

* "*Scientific American Sup.*," 836.

Ver'tic-al Mul'ti-flue Boil'er. A form of boiler with flue pipes extending between the crown plate of the furnace and an upper flue

Fig. 2513.

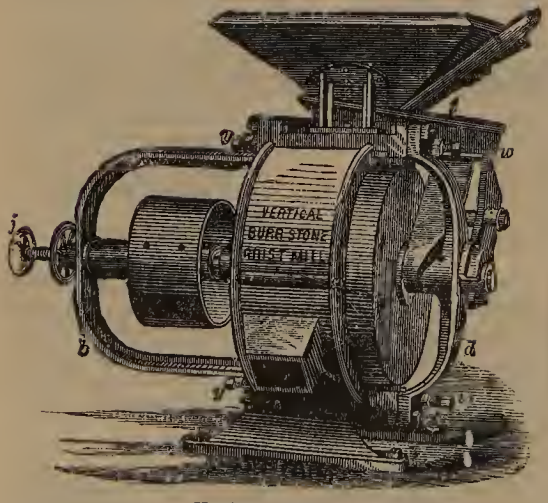


Vertical Steam Engine.

Ver'tic-al Burr Mill.

Silliman's vertical burr stone mill, Fig. 2512, has large openings for receiving and discharging the grist. It is never liable to choke or clog; the grain drops from the shoe directly into the radiating centrifugal feeder, which throws it evenly between the stones on all sides alike, above as well as below; thus for the first time obviating a vital objection to all vertical mills. In taking the mill apart to dress the stones, the foundation bolts are never disturbed, and each

Fig. 2512.



Vertical Burr Mill.

stone is taken out separately. As shown by the cut it is so constructed that it may be belted to from almost any direction, above, below, or at either side, as most convenient.

See also, Fig. 2316, p. 1021, "*Mech. Dict.*"

Ver'tic-al Drill. The "Niles" vertical drill is calculated for drilling from 1½″ to the smallest

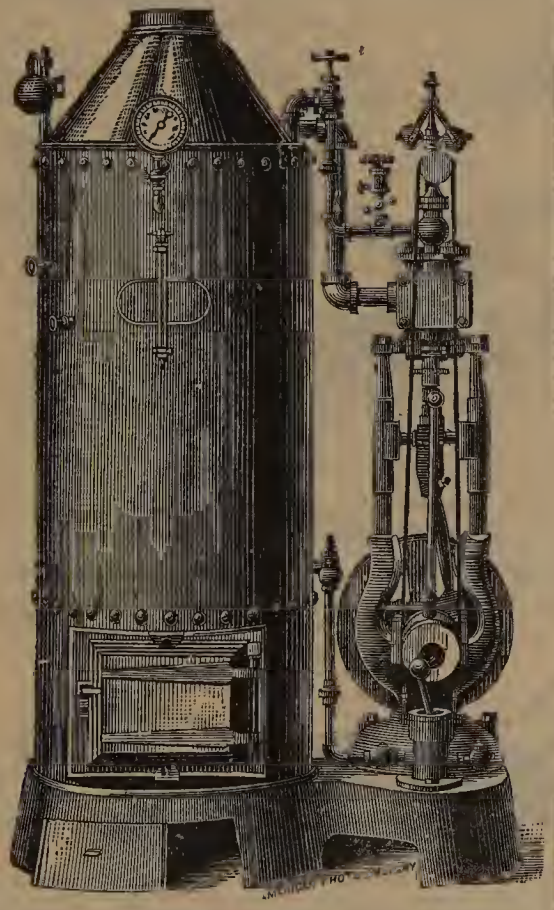
plate, being surrounded by the water in the boiler. See MULTIFLUE BOILER.

Ver'tic-al Steam En'gine. Fig. 2513 represents Maxim's automatic steam engine.

The cylinder is 2″ in diameter and has 2½″ stroke of piston. It is supplied with all the attachments used in large engines, the governor being inside the belt pulley, and operating directly on the point of cut-off, enabling a small amount of steam to do a large amount of work. The engine is ready to work in ten minutes from lighting the gas, and will run all day without any attention whatever. With a supply of gas and water it is its own engineer and fireman. It is admirably adapted to the use of dentists, jewelers, and amateurs.

Lovegrove's portable engine, Fig. 2514, occupies a floor space of only 20″ × 34″. The boiler is 18″ diameter and 42″ high. It is made of charcoal hammered iron and contains 20 2″ tubes, 30″ long, and is tested to 200 lbs. pressure, though the working pressure is from 60 to 90 lbs. With this boiler and a cylinder 3″ diameter and 4″ stroke, is obtained a two horse-power. The engine is fitted with all the necessary ac-

Fig. 2514.



Vertical Portable Steam Engine.

companiments of pumps, valves, etc., complete. It is furnished with the Pickering governor, and the steam and exhaust connections are quite short, avoiding expense in long pipe and waste of steam. The pulley which drives the governor affords connection for the pump at the same time. The vertical guides are bolted to the base plate, and are fitted up in as plain and substantial a manner as possible. There is a complete supply of lubricating valves, gages, blow-off valve, etc. The fly-wheel is 12″ diameter and 3″ face, and insures steadiness of motion.

In the "Shapley" vertical engine and boiler, the engine is not attached to the boiler but rests on the same base, permitting adjustment of the parts, if necessary while steam is on. The boiler is in two sections, the upper part of which serves as a steam space. The fire-box is conical and from it radial tubes communicate with an annular smoke space having down-cast flues passing perpendicularly through the boiler, and conveying the products of combustion after passing over water to the smokestack, into which the exhaust steam is also discharged.

N. Y. Safety Steam Power Co.	* "*Manuf. & Builder*," ix. 73.
	* *Thurston's* "*Vienna Exp. Rept.*," ii. 27.
Snyder	* "*Eng. & Min. Jour.*," xxvi. 256.
	* "*Manufacturer & Builder*," ix. 247; x. 201.
Whitmore	* "*Iron Age*," xvii., Jan. 27, p. 1.
Double-acting, *Turner*	* "*Scientific American Sup.*," 1764.
Small	"*Scientific American Sup.*," 1839.
Blake	* "*Scientific American Sup.*," 165.
Haskins	* "*Iron Age*," xix., June 14, p. 1.
Head, Br	* "*Engineering*," xxi. 270.
Heald & Sisco	* "*Manuf. & Builder*," xi. 245.
Hampson, Whitehill & Co.	* "*Manuf. & Builder*," viii. 103.
Lovegrove	* "*Iron Age*," xxi., May 2, p. 41.
	* "*Manufacturer & Builder*," viii. 52; x. 81.
	"*Scientific Amer.*," xxxviii. 34.
Shapley	* "*Iron Age*," xxi., May 2, p. 41; xxii., Aug. 8, p. 30.
Fitchburg St. Eng. Co.	* "*Iron Age*," xxii., Aug. 8, p. 29.
Mundy	* "*Iron Age*," xxii., Aug. 8, p. 29.

Ver'tic-al Ten'on-ing Ma-chine'. Fay's car gaining and tenoning machine has traversing cutters and automatic feed. The table is low, and the cutter-heads are adjusted independently by a screw to each, so that they can cut a tenon of the desired thickness, with any proportion of shoulders within the capacity of the machine.

The back of the upright stand carries a head for gaining a double tenon to 4″ in length. This is raised by a screw, and can be moved out of the range of single tenoning. The side of the upright stand has a movable piece, which when taken out makes the whole length of the tenon 12″.

The belt that drives the heads is retained at its proper tension by a sheave and weight in connection with a binder pulley, that compensates for the motion of the heads. The table rests upon friction rollers that run upon planed ways, one of which has a groove in which is fitted a corresponding tongue on the table, to keep it at a constant right line with the line of the heads.

Ver'tic-al Tube Coil. An arrangement for steam heating purposes.

Ver'tic-al Tu'bu-lar Boil'er. The Safety Steam Power Co.'s tubular boiler has the tubes pass at about the water-level, through the baffle plate. A large tube hangs from the center of the plate, nearly to the crown of the furnace, and an annular space is left around the ontside of the baffle and between it and the outer shell sufficient for the easy escape of the steam and water.

This arrangement is intended to stop the current of steam and water tending to shoot up between the tubes, and compel it to flow outward and escape between the baffle and shell, at which point the steam and water separate. The steam is taken off from the center of the boiler, and as the steam is delivered at the outer edge of the baffle it must flow inward, between and around the tubes, on its way to the engine, becoming dried and slightly superheated.

Vi'bra-ting Ap'pa-ra'tus.

Affecting chemical phenomena, *Berthelot*	* "*Scientific American Sup.*," 3829.

Vi'bra-ting Ar'ma-ture. (*Electricity.*) The moving bar at the end of the helix by which the circuit is opened or closed, automatically or otherwise.

Vick'ers Steel. (*Metallurgy.*) A steel made by combining iron scrap, ground charcoal, and oxide of manganese.

Vig-net'ter. A mode of making vignetters by means of gelatine-chromate is:—

From a good positive in black or some non-actinic color a number of negatives of different sizes are taken, but in doing this the image on the ground glass plate must not be focused too sharply. Or, where suitable vignettes are already at hand, the negatives can be taken from them directly

by any convenient method; either a collodion emulsiou may be used, or chromated gelatine, as described below. To prepare the latter a solution is made of five parts pure white gelatine in sixty parts of water, to which two parts of ammonium bichromate are added, and, when the film is afterward to be drawn off, a few drops of glycerine may be introduced to make it less brittle.

After filtering this solution, pour it, while still hot and fluid, on a well-cleaned glass plate; care must be taken to have this plate placed in a perfectly horizontal position, which is best effected by resting it ou a larger plate that has already been carefully leveled. The gelatine solution must not be allowed to run over the sides of the plate, or the film may turn out to be too thiu; to prevent this give the plate a raised edging of wax. When the chromated gelatine has set, let the plate dry completely in a dark and moderately warm roou.

Artificial heat should not be used in drying, especially when the film is afterward to be drawn off; when this is the case, the plate should first bc rubbed over with powdered talc or diluted ox-gall, and then, ou heating, the film easily flies off.

On plates prepared in this way the negatives are now copied, and that as intensely as possible by a long exposure. The copies cannot be too iuteuse, provided that the negatives are quite black in the center of the aperture. When they have been sufficiently exposed, wash them several times in cold water, and, finally, with distilled water; then plunge them, while still wet, into a solution of one part lunar caustic in fourteen parts water acidulated with one part acetic acid. It will now be seen that the film is coated with a precipitate of silver chromate, which is in the highest degree non actinic, and is much denser toward the side of the plate. Should there be a trace of chrominm salt left, as is often the case, it is of uo importance; on the contrary, when really intense vignetters are required, it is not necessary to thoroughly wash out the chrominm salt. But in order to obtain the requisite transparency in the center of the plate, the whole of the silver nitrate must first be washed out, and then a soft and strong hair brush dipped in dilute nitric acid. This is passed over the plate with a few rapid strokes in a circular direction from the center outward up to the commencement of the shading, and the plate is then qnickly rinsed. With a little skill a great variety of effects may be obtained in this way, and any required degree of shading.

After drying, the film is coated with a little castor oil collodion, and then, if it be desired to draw it off, with a hot twenty per cent. solution of gelatine to which a small quantity of glycerine has been added. The plate must be laid horizontal, and the addition of a little alcohol to the solution facilitates its flowing. When the gelatine is set, the plate is placed for a couple of days to dry, and it is again coated with some thin collodion; the edges are then cut through, and the film is drawn off.

Vi-gogne'. (*Fabric.*) A silk-and-wool, or an all-wool French dress goods.

Vig'o-rite. A nitro-glycerine explosive, manufactured at Marquette.

Bjorkmann, of Stockholm, Sweden, gives the following recipe for the manufacture of the new explosive, vigorite: Mix in a wooden or rubber vessel 5 to 20 parts of sugar or molasses, 25 to 30 parts of nitric acid, and 50 to 75 parts of sulphuric acid. 25 to 50 parts of this mixture, called nitroline, are mixed with 15 to 35 parts of nitrate of potash and 15 to 35 parts of cellulose.

Vi-nasse'. The residuum of the wash in the still after distillation.

(*Beet-root.*) The residuum of the distillation of fermented beet-root molasses.

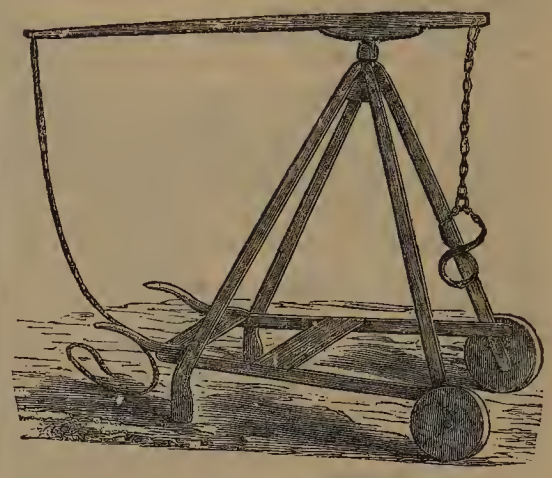
Vine Pull'er. A machine for extracting vines, Fig. 2515. A pair of double-grip pinchers hang by a chain from a double-pivoted lever that surmounts a truck-frame.

Vine Shear. See PRUNING SHEARS.

Vine'yard Bisse. A French double vineyard plow.

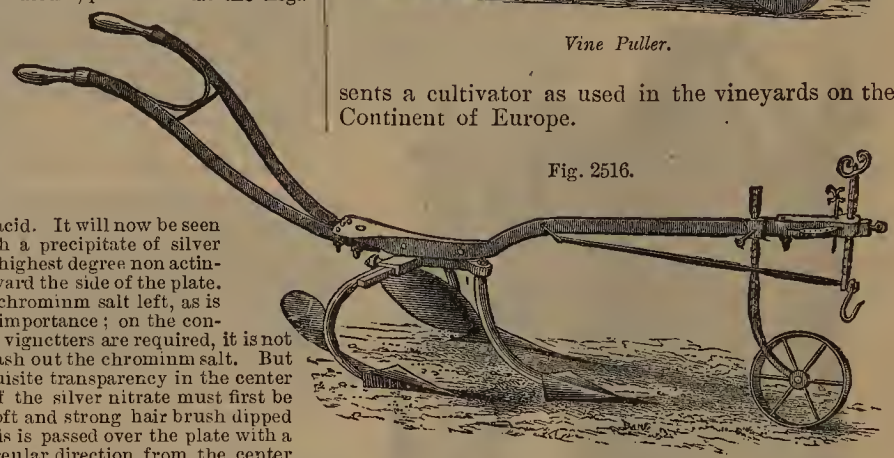
Vine'yard Cul'ti-va'tor. Fig. 2516 represents a cultivator as used in the vineyards on the Continent of Europe.

Fig. 2515.



Vine Puller.

Fig. 2516.



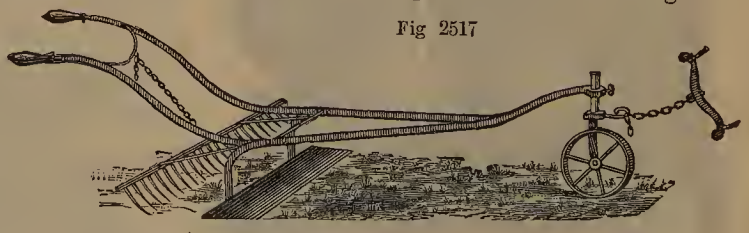
Vineyard Cultivator.

A combined horse-hoe and rake, Fig. 2517, in use as a cultivator in French vineyards.

Cal., *Ross* . "*Min. & Sc. Press*," xxxvii. 69.

Vine'yard Im'ple-ments. Dr. Knight's report on agricultural implements at the Paris Exposition of 1878 (see "*Paris Exposition* (1878) *Reports*," vol. v., pp. 216–223) describes and illustrates the following: —

Fig 2517



Horse Hoe and Rake.

Vineyard plow, *Moreau-Chaumier*	France.
Déchausseuse, *Renault-Gouin*	France.
Rechausseuse, *Renault-Gouin*	France.
Plow for hilly ground, *Moreau-Chaumier* . .	France.
Vineyard plow, *Renault-Gouin*	France.
Double mold-board plow, *Moreau-Chaumier* .	France.
Gang plow for vineyards, *Renault-Gouin* . .	France.
Vineyard plow of Burgundy, *Renault-Gouin* .	France.
Vineyard horse-hoe, *Souchu-Pinet*	France.
Vineyard harrow, *Souchu-Pinet*	France.
Scraper and rake, *Renault-Gouin*	France.
Machine for crushing and stalking grapes, *Chavanette*	France.
Grape crusher, *Meixmoron de Dombasle* . .	France.
Grape mill, *Mabille Frères*	France.

See also PRESS.

Vi'no-sal-o-rim'e-ter. The vino-salorimeter is a modification of the old colorimeter of Payen, but its dimensions are much smaller, and the addition of the micrometer screw allows the depth of the layer of wine to be measured with accuracy.

Vi'o-lin. For history of the violin in the United States, see report of H. K. Oliver on Group XXV., in vol. vii. of "*Centennial Exhibition Reports*," p. 48.

The President de Brosses, "*En Italie*" (1739), mentions a virtuoso in Florence, Tagnani. "Il a inventé une clef aux violons faites comme celles des flûtes, qui s'abaisse sur les cordes en poussant le menton, et fait la sourdine; il a assez ajouté, sous le chevalet, sept petite cordes de cuivre, et je ne sais combieu d'autres mièvretés." I. 272, ed. 1858, Didier, Paris.

The inventiou of laying the strings over and above each other is certainly a very old one. Even before the invention of the hammer-piano there was added to the bass strings of the old clavichord a string sounding the higher octave. This string was fastened upon a bridge which is situated below the lower strings upon the sounding-board. Various experiments to utilize the crossing of the strings failed utterly, so that even authors of repute believed that strings lying above each other threw their respective vibrations into confusion. This, however, is not the case, as is sufficiently proven by Helmholtz's analysis of the system of sound-waves. This is done no more when lying above each other than by strings lying side by side.

The vina of India has an antiquity of 2,500 years at least. The bow is claimed to have been invented in India.

Pocket . . . . * "*Manufacturer & Builder*," viii. 187.

Vis-co-sim'e-ter. The viscosimeter is the name given to an instrument by means of which the viscosity of a sample of beer can be determined.

It consists in its simplest form of a funnel-shaped vessel, the lower extremity of which is drawn out to a fine point, so that the internal diameter is as fine as a capillary tube. A certain quantity of distilled water being placed in the funnel-shaped reservoir, a determination is made of the quantity which will run through in a given time, say five minutes; for example, we will assume this to be 21 cubic centimeters; the same quantity of the beer to be tested is then placed in the instrument, and an observation made of the quantity running through in the same time, we will suppose this to have been 15 cubic centimeters. This viscosity is in inverse proportion to the quantity of fluid flowing through the tube in a given time; taking the viscosity of water at 1,000, we have the following proportion: —

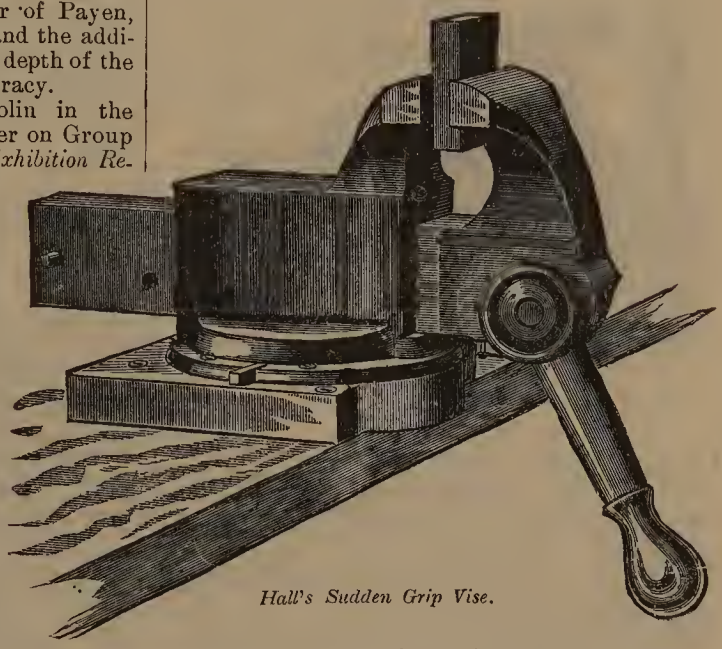
$$15 : 21 :: 1000 : V.$$
$$V = 1400.$$

Many precautions have, of course, to be taken; all determinations must be made at the same temperature, and, if possible, at the same barometric pressure; any excess of carbonic acid gas should be previously removed from the beer, by shaking a portion of it in a bottle until no more gas is given off; if the beer is at all thick it must be filtered, otherwise some of the suspended particles may mechanically close up the capillary tube. The determination of the viscosity of beer is of value for many purposes, for any great excess is an unfavorable sign. Any tendency toward "ropiness" can be detected by this instrument. It would also probably be of considerable value to the practical brewer for testing his worts, with the view of determining the dextrine ratio. A dextrinous wort will run through much slower than a saccharine wort, and we think some very useful results might be obtained by the aid of this instrument. Its construction is very simple, and any one with but a slight experience in chemical manipulation may make one for himself.

Vise.

Fig. 2518 represents Hall's sudden grip vise. It is intended to save the time used in operating a screw vise. The movable jaw and sliding bar are cast in one piece, with a hollow chamber below, to contain the working parts of the vise. The stationary jaw is so cast that the sliding bar fits into it, and with a base to fit the swivel plate. The lever has two disk-like portions on each side to fit into recesses in the under part of the movable jaw, and having frictional surfaces around the peripheries. A band retains the lever in the recess, and an adjustable screw regulates the tension of the band.

Fig. 2518.

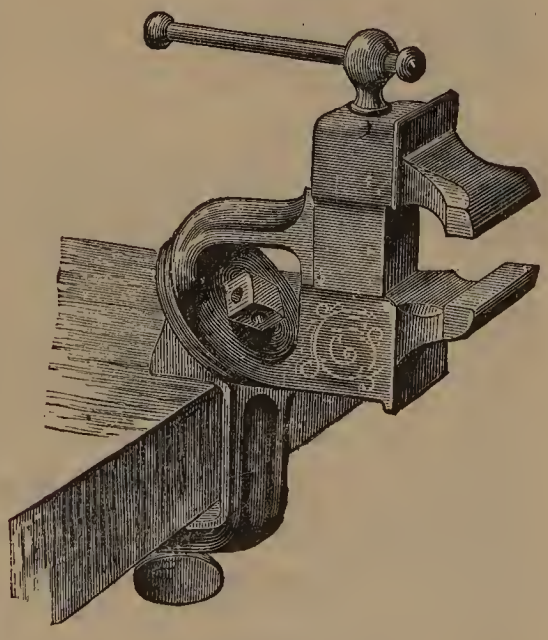


Hall's Sudden Grip Vise.

Smith's heavy chilled beam vise is one with sufficient weight of metal to give it the inertia of an anvil. The jaws move parallel so as to take a firm hold.

Stevens's vertical and horizontal vise, Fig. 2519, here illustrated, is so hung upon an angular swivel that a half revolution upon its base brings the jaws from a vertical position to a horizontal position. In their passage from one position to the other, the jaws occupy every angle of inclination, and the vise may be fastened to its base in any position. Our illustration represents a jeweler's portable or clamp vise,

Fig. 2519.

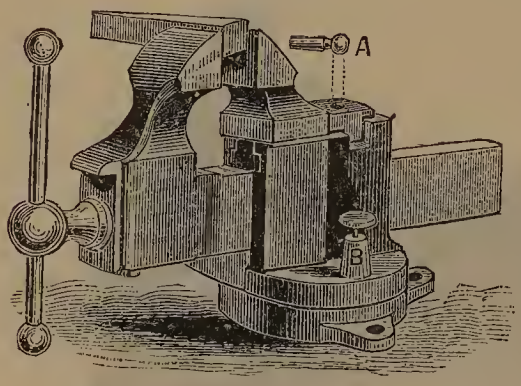


Vertical or Horizontal Vise.

arranged to fasten to any table without marring it. The two plates of the swivel are faced true, and held together very firmly by a central bolt, which may be made fast by a tenpenny nail as a lever to turn the bolt. The larger vises turn upon a large cylindrical bearing which projects into the lower plate, the plates and bearing being turned true, and the binding bolt, or nut, is turned by any wrench beneath the bench. It may be changed from one position to the other in a few seconds.

The Prentiss vise, Fig. 2520, has a back jaw that is adjustable and in use instantaneously conforms by automatic ac-

Fig. 2520.



Angle Vise.

tion to any angle, adjusts itself, and makes firm the object held, whether it be straight, beveled, or wedge-shaped. Or, if desired, by inserting the pin *A*, the jaw becomes fixed and immovable, thus making a perfect parallel, or solid jaw vise.

The adjustable jaw, resting and working as it does upon and against the solid body of the vise, is thereby rendered absolutely as strong and durable as the old permanent jaw. By means of the new patent swivel bottom this vise may be readily adjusted to any angle, right or left, at will of operator, by simply raising rachet-pin *B*, which, on being freed, is instantly forced home by a spring, rendering the vise solid and firm as if stationary.

See also under SUDDEN-GRIP VISE.

The following are the names of vises of various designs : —

Parallel bench vise, round jaws.
Swivel bench vise, round jaws, with cast-steel anvil.
Oval slide bench vise.
Round slide, double swivel bench vise.
Swivel bench vise, swivel jaw.
New model swivel bench vise.
Sudden-grip bench vise.
Improved swivel bench vise.
Stationary parallel bench vise.
"Rapid Transit" parallel bench vise.
"Rapid Transit" swivel bench vise.
"Rapid Transit" woodworkers' bench vise.
Woodworkers' parallel bench vises.
Woodworkers' swivel bench vise.
Woodworkers' swivel bench vise, with swivel jaw.

Newell	"*Engineer*," xlii. 42.
Simpson	"*Iron Age*," xxi., May 2, p. 25.
Smith	"*Scientific American*," xxxiv. 54.
Starkey	* "*Scientific American*," xxxix. 370.
Zanetti	* "*Scientific American*," xlii. 51.
And anvil drill	* "*Scientific American*," xlii. 130.
Bench, *Hall*	* *Thurston's* "*Vienna Exp. Rept.*," iii. 257.
Parallel, *Fisher & Norris*	* "*Scientific American*," xl. 7.
Parallel, *Simpson* . .	* "*Iron Age*," xvii., Jan. 27, p. 20.
Penfield	* "*Iron Age*," xvii., March 30, p. 1.
Sinclair	* "*Iron Age*," xix., March 1, p. 18.
Solomon	* "*Scientific American*," xxxix. 390.
Stevens	* *Thurston's* "*Vienna Exp. Rept.*," iii. 295.
Swivel-jaw, *Bonney* . .	* "*Iron Age*," xxii., Nov. 14, p. 5.

Vise Cap. A brass cap for the upper section (the contact edge) of a vise.

Vise Clamp. A device with serrated jaws for holding pipes, rods, etc.

Vise Clamp. A clamp for temporarily fastening the vise to the bench or other object to which it is attached.

Vis-i-om'e-ter. An instrument by which to determine the numbers of lenses.

A proposed formula of procedure is in multiplying the distance of normal vision (12°) by the distance of distinct vision, and dividing the product by the difference between the two.

Vode. (*Fabric.*) An all-wool French dress fabric made for religieuses.

Vol'ley Gun. (*Ordnance.*) See MITRAILLEUR.

Volt. (*Electricity.*) The *practical* unit of electro-motive force. Equals one hundred million absolute units of potential. 1 volt = 10^8 (C. G. S.). — *Gordon.*

Vol-ta'ic Ar-ma-dil'lo. (*Surgical.*) A battery of plates in a belt or sole, linked together so as to resemble, in a degree, the cuirass of an armadillo.

Vol-ta'ic Pen'cil. There is at the present time scarcely a single branch of industry to which electricity is not lending its aid. Art, however, has thus far received but little benefit from this source, if we except the application of electricity to electro-metallurgy.

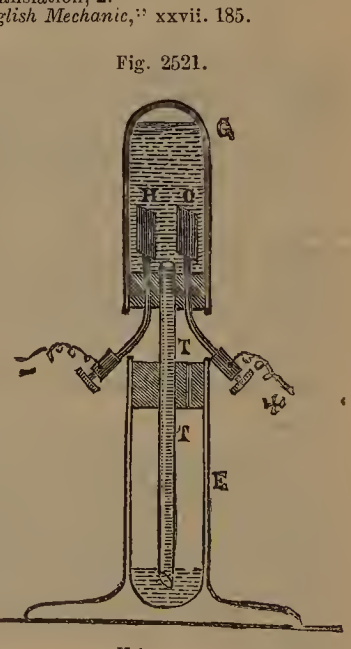
An important discovery, however, has just been made in Paris, by M. Bellet, whose invention consists of a voltaic pencil, by the use of which designers and draughtsmen may be enabled to dispense entirely with the aid of the engraver. The editors of "*Electricite*" state that they have examined beautiful proofs of lithographs and etchings obtained, without the use of the engraver, by the effect of a voltaic arc produced at the point of an ordinary lead pencil. Encouraged by this success the inventor has taken out patents in various countries, and a company has been formed to carry out the process, which will soon be placed before the public. At present there are being prepared models of a series of apparatus which will allow any artist, however ignorant of the mysteries of electricity, to reproduce immediately, and without the aid of any artisan, the most delicate and complicated drawings; and this, too, by a very simple process and at a very moderate price. By a slight modification of the system there may be produced: 1. Stencils analogous to those produced by the Edison pen; 2. Lithographs; 3. Etchings; 4. Stereotypes for typographical work. The initiators of this discovery are confident that an entire revolution will take place in the process of illustrating papers by means of their electrography. Either copper or zinc plates may be used. A late number of "*Nature*" describes the *modus operandi* as follows: A thin sheet of paper is attached to the plate. One of the poles of a Rhumkorff machine is connected to the plate, and the other pole to the top of the pen. The electricity then runs through, making a spark which perforates the paper in whatever direction the artist directs the pen. As soon as the drawing is finished, the paper is rubbed over with greasy ink, laid on with an ordinary roller. The paper is removed, and the plate is dipped into the acid, which cuts away those portions not protected by the ink. The light of the spark is said to be sufficient for the artist, even when he works in a dark room; and the pen is stated to be as manageable as an ordinary pencil.

Vol-ta'ic Pile. (*Electricity.*) A number of disks of silver or copper, wet cloth or zinc, in the order named. Invented by Volta in 1800. See Fig. 6990, p. 2714, "*Mech. Dict.*"

Also * "*Scientific American Supplement*," 2489.
Niaudet, American translation, 2.
Ayrton & Perry, "*English Mechanic*," xxvii. 185.

Vol-tam'e-ter. Fig. 2521 represents a detonating voltameter.

Fig. 2521.



Voltameter.

The following experiment, due to M. Bertin, is but little known, yet is exceedingly interesting, inasmuch as it puts on evidence certain phenomena connected with the polarization of electrodes which always take place under different conditions. The simple apparatus, represented in the engraving, consists of an inverted bell glass, *G*, closed with a cork, through which pass two platinum wires provided at their ends with broad plates, *H O*, of the same metal. It is supported by a

glass tube, *T*, open at both ends, and fixed in the cork which closes the mouth of a test glass *E*. Two wires from the batteries are connected with the platinum wires by means of ordinary binding screws. The bell glass *G* is filled with water acidulated with one tenth of its volume of sulphuric acid. If this mixture be now decomposed by a strong current from a Bunsen battery of 50 elements, the water will be seen to lower very rapidly; and when the bell glass is almost full of gas, the mixture will detonate spontaneously, and be seen to take fire. This experiment is not attended with any danger whatever; the recomposition of the products of electrolysis takes place immediately, and during the passage of the current. It is necessary that this polarization current should have a certain tension; the phenomenon does not take place with a battery of 30 elements, but is at once spontaneously produced when the 20 elements that are necessary to make up the complement are added. With 30 elements, instead of a detonation, there will be observed a phenomenon of a different nature, but none the less curious. The water, which at first lowers very rapidly to some millimeters below the platinum plates, all at once stops, in spite of the disengagement of gas on the wires. The plates recompose above what the wires decompose below.

By using pure water the decomposition takes place more slowly, and the detonation is not produced, even with 50° Bunsen elements. Still, a curious phenomenon is produced: the water lowers to the base of the plates, and then does nothing but oscillate between the base and top of these. The water is decomposed below and recomposed above. A weaker current, of 30 elements, decomposes the whole.

These curious phenomena are due to the polarization of the electrodes and not to the catalytic force of the platinum, for they may be obtained with electrodes of various metals.

Edison . . . . . "*Manuf. & Builder*," x. 230.
Detonating, *Bertin*, Fr.. * "*Engineer*," xlvi. 123.
Explodiug, *Bertin* . . * "*Telegraphic Journal*," vi. 399.

Vo-lute' Spring. A spring made of a flat bar of steel coiled with a kind of seroll resembling the volutes used as an ornament in the capitals of ancient Roman and Grecian architecture. The coil is made in a conical form so that the spring can be compressed in the direction of the axis around which it is coiled.

Vul'can-ite. Sulphide of caoutchoue; sulphur and india-rubber.

India-rubber in its crude state becomes soft when subjected to heat, and very hard and rigid when exposed to severe cold; but, by the vulcanizing process invented by the late Mr. Charles Goodyear, — which consists of incorporating with the rubber a small proportion of sulphur, and subjecting it to from 250° to 300° of heat for several hours, — it is rendered uniformly elastic when exposed to the most intense cold or to any reasonable degree of heat. Steam "heaters" for vulcanizing are of cylindrical form, 5′ to 6′ in diameter and over 50′ long. These heaters are of wrought iron, one end opening on hinges, and through this open end the goods to be vulcanized are run in on a railway carriage. The end or door is then closed, and the steam let on and maintained at the proper temperature, ascertained by the aid of thermometers placed in the top of the heater, until the articles in it are thoroughly vulcanized. Vulcanizing under the pressure of metallic molds or sheets imparts to the articles so vulcanized a solidity and quality not otherwise obtainable. In the manufacture of rubber from 3 to 10 per cent. of sulphur, and various metallic oxides — chiefly lead and zinc — are combined with it; the quantity of the latter depending on the degree of elasticity and other properties required in the article to be manufactured; and to judiciously combine these substances with the rubber in suitable proportions to produce the desired end, as well as in properly vulcanizing it afterwards, requires great experience and skill. A certain degree of honesty on the part of the manufacturer is also essential to abstain from introducing more adulterating substances into his "compounds," and thus cheapen the product at the expense of its quality; and we are sorry to say that this latter practice is carried to excess by some ignorant or unscrupulous manufacturers, whose aim appears to be to make — what always proves very expensive to the consumer — a low priced article regardless of its quality, with a view of underselling more reputable and skillful manufacturers.

It is a common error with persons not conversant with the subject, to suppose that rubber in being manufactured is treated with solvents, and can therefore, if necessary, be run into a mold like molten lead; but this is entirely a mistake, as since Mr. Goodyear's invention of vulcanizing rubber no solvents have been used in its manufacture, the entire mixing being done by the operations of machinery, after the manner of mixing dough for bread; and at no stage of the process up to the time of vulcanizing is the rubber softer than stiff dough, and consequently it has to be pressed and molded into the various forms required.

Vul'can-ized Fi'ber. Paper, paper pulp, or other vegetable fibrous substance that has been so prepared by saturation, and coating with chloride of zinc, or chlorides of tin, calcium, magnesium, or aluminum, etc., as to give it in a measure metallic toughness and strength.

Vul'can-ized Glass. This invention consists in the sudden cooling of all kinds of glass (in proportion to the temperature at which they must be worked), at a temperature relatively high in relation to their qualities, by plunging them into baths composed, when the glass consists chiefly of silicates of potassa and of lead, of the following substances: cheap oils or fats, and by preference paraffine heated from 450° to 550° F.; glycerine, among other advantages, is not so liable to catch fire, and has more favorable properties in regard to the temperature at which the glass has to be worked; glycerine can easily be maintained at a temperature of 480° F., which is its boiling point, when an addition of basic salt raises its boiling point to a constant temperature of 530° to 600° F. The silicates of potassa and lime, and the silicates of carbonate of soda and lime, require a much higher temperature. Hydrated sulphuric acid boiling at 600° to 640° F. can be used with advantage. The silicate of soda and of lime, which melts at 1,200° to 2,300° F., must be cooled in melted saltpeter, or in an alloy of metals composed of antimony and tin, which melts at 460° to 680° F., while for the silicates of borax and baryta the cooling has to be done by an amalgam of lead and antimony, the melting point of which is 750° F.

Vul'can-iz-ing. In vulcanizing caoutchoue the purified and masticated gum is kneaded on warm rolls with the proper proportion of flowers of sulphur. Other substances, as whiting, white lead, litharge, zinc oxide, disintegrated refuse rubber (vulcanized), etc., are often added to increase the volume of the product and economize the more costly caoutchouc. Lead compounds blacken the goods through the formation of lead sulphide.

The heating or vulcanizing is conducted in strong cast-iron cylinders, one end of which is movable and serves as a door. The goods to be vulcanized are loaded upon a car and run in upon a railway extending along the bottom of the chamber. Powdered steatite (soapstone) is freely used to prevent adhesion of the different articles, the goods often being packed in boxes filled with this substance. When the heater is charged and the door made fast, high pressure steam is admitted until the desired temperature is attained. This varies somewhat with the character of the articles — according to Dr. Chandler, five hours at 240° Fah. is said to be the temperature for fire hose. In factories where smaller articles are made, the goods are generally exposed in the heaters for four to four and one half hours, the temperature, at first about 250°, gradually being augmented to 275° Fah., at the termination of the operation. A temperature exceeding 280° Fah. injures the goods. Hard rubber, vulcanite, or ebonite differs from ordinary vulcanized rubber only in that a much larger proportion of sulphur enters into its composition and the vulcauiziug process is conducted at a more elevated temperature. Usually the caoutchouc has incorporated with it half its weight of sulphur; but, as in the preparation of soft rubber, various foreign substances — metallic sulphides and oxides, shellac, asphaltum, etc. — are often added. Mixed with a litharge it becomes very black; with sulphide of mercury (vermilion), bright red; and composition similar to the red vulcanite used for dental purposes is prepared with six parts of sulphur, sixteen of caoutchoue and eleven or twelve of vermilion.

The vulcanizing operation is usually conducted at temperatures increasing from 275° Fah. to 305° Fah., the time required being about six hours. The articles are packed in steatite or supported in water trays in the vulcanizer, and, if to present a glossy exterior, are sometimes enveloped in thick tin foil.

Thin sheets of rubber or small articles are sometimes vulcanized by what is called the cold process (Parks's). In this the caoutchouc is simply immersed in a mixture of forty parts of carbon disulphide or benzolene and one part of sulphur chloride. It is next placed in a room heated to 70° Fah., and when all the carbon sulphide has been volatilized

the process is in so far complete that it is only requisite to boil the material in one pound of caustic potash in about 2 gallons of water, the vulcanized caoutchouc being next washed to remove excess of alkali. The results of this treatment are not always satisfactory, owing to the superficial action of the vulcanizing substances.

Vul'can-iz-ing Flask. Hayes's flask and clamp is intended for vulcanizing ovens, boilers, etc. The lug joint of the clamp is so constructed that all the strain comes on the casting. The pin only serves to keep the lug in place when not in use.

W.

Wab'ble Saw. One set at an angle to the arbor, to cut a wide kerf or groove.

Wag'on Box Rod Plate. The washers attached to the wagon box on which the rod-nut turns.

Wag'on Seat. Fig. 2522 shows a lap seat spring that is hinged in front so as to make a turn-over seat.

Fig. 2522.

Wagon Seat.

Walk'er Bat'tery. (*Electricity.*) A modification of the small battery in which the negative plate of platinum is replaced by platinized carbon of the gas retort.

Niaudet, Am. trans., p. 56.

Walk'ing Cul'ti-va'tor. A corn cultivator or plow with which the driver walks, in contradistinction to a sulky cultivator, in which he rides.

Wall Crane. One affixed to a wall as a hand power foundry or forge wall crane. It is attached to a wall or column so as to command a sweep over a given area, an overhead traveler reaching the nearer positions.

Wall En'gine. One attached to a wall, usually vertical and serving either to drive shafting, or supply feed-water to a boiler. See instances in *Aimer's*.

"*Engineer*" . . . . . * xlv. 393.

Wall Knot. The wall knot, either single or double, forms a handsome ending to a rope. To make a single wall untwist the ends of a rope — in half-inch rope the strands must be untwisted for ten or twelve inches — and make a bight with the first strand; pass the second strand over the end of the first, and the third strand over the end of the second and through the bight of the first, then haul tight.

Wall and Crown. This knot should be finished with a crown: Lay the first strand over the walling, the second strand across over the first, and the third strand across over the second and through the bight of the first; then haul the ends tight, pinching the knot into shape as you haul. When it is made snug and tight, cut the ends of the strands off close to the crown.

A double wall knot is made over a single wall by passing the ends, singly, close underneath the first wall, and thrusting them up through the middle, the last end coming up under two bights, then finish with a crown.

Wall Pa'per. Ornamented paper for decorating the walls and ceilings of rooms.

Paper-hangings are necessarily divided into two classes — hand-printed papers and those made by machinery. These papers differ materially from each other in cost of manufacture and durability when in use; a hand-printed paper being worth, at least, twice as much, and frequently twenty times as much, as the same pattern would be if produced by machinery, and, as it is frequently impossible for a person unacquainted with the trade to detect the one from the other, especially if the two modes of manufacture are mixed, great care ought to be exercised in the purchase of paper-hangings; the fact being that very few dealers are aware of the class of goods of which their stocks are composed, and hence arises the great differences in the estimates supplied by competing paper-hangers. The public will do well, therefore, to deal only with practical men. The cause of this great difference we will now endeavor to find out.

There are various kinds of paper-hangings made in this country, all of which are made in pieces of eight yards long, or double pieces, sixteen yards long. In France the standard length is nine yards, and in England twelve. The cheapest kinds of paper-hangings are those manufactured by machinery, in which case the design is cut upon a cylinder, or rather a series of cylinders, for each color requires a separate cylinder. The cylinders, when set in motion, are filled with color much after the manner in which a printing machine is supplied with ink. The papers are run off some hundreds of yards long, and are then cut to the required length of a piece. A machine will print some thousands of pieces in a day, complete with all their colors, while a man will not hand-print more than one hundred, and that in one color only; but then the machine-printer must use his colors so composed that they will flow into the machine in a state something like printers' ink, and must only use such binding materials for sizing his colors as will not be impaired by being subjected to the great heat to which the paper so made must be subjected in the drying process. Now all this is exceedingly injurious to colors, and very much affects their durability and softness of tone; hence the extremely fugitive character of all paper made by this process. The hand-printer, on the other hand, can use his colors in considerable thickness, and as he only puts in one color at a time, and then allows his work to dry in the ordinary temperature of a room, before he adds the next color, he can use as a binding medium a well-made spetch size, and thus produce firmness and stability of color; and as he only lays on one color at a time, he secures clearness and delicacy of outline utterly unapproachable in machine-made papers; in fact, the one will last ten years without fading where the other would not be fit to look at in three.

Block-made papers are composed of various qualities of cartridge-paper, upon which a solid flat ground of distemper is laid, and the design stamped upon it with a block upon which the pattern has been cut. According to the quality of the cartridge-paper and ground-work, as also the number of times it must go through the stamping process to produce the various tints and shading of the pattern, is the price of this kind of paper-hanging regulated.

The next class of papers is composed of those that have satin grounds, the luster of which is produced by friction. These grounds are often embossed with patterns, some of which represent watered silk, and others a flowered or striped pattern. Upon this a colored pattern is printed in distemper, in the same way as upon the plain grounds. This class of paper-hangings is of all others the best, as it is the most impervious to the absorption of moisture from the atmosphere, the most easily cleaned, and decidedly the most durable.

Another class of papers is that called "floured" or "velvet" paper, and is produced by the pattern being stamped on any description of ground-work with Japan gold-size, and dyed wool, ground into a powder, shaken over it while the pattern is wet. This woolen powder, which is called "flour," then adheres to the Japan gold-size, which forms the figure

of the pattern. When dry, the loose "flour" is dusted off and the pattern is generally then enriched by the application of additional blocks, with color or dry; in the latter case the "flour" receives an impression which considerably enhances its effect. It is this class of "flour-paper" to which Scott's new process applies. Several coatings of "flour" are added one upon the other, until a considerable amount of relief is obtained. The whole surface is then sized and painted, and a very handsome and durable wall surface produced.

The next class of wall-papers embraces those in which the pattern is either wholly or partially produced by metal. The metal is either applied in powder, in a similar manner to "flour," or in leaves, like those of gold. This metallic powder is hisulphurate of tin, and the leaf metal is made of fine copper, or a mixture of copper with zinc, tin, or some other metal that will give it more the color of gold than when in its natural state. These metals are often added to colored and floured patterns. Paper-hangings upon which leaf metal is employed are much more expensive than those done with the metallic powder only; but the leaf kind has much greater brilliancy, and is more durable than the other, especially — if — as is now very frequently the case — the pattern be stamped into the gold with a die. Many papers so produced are exceedingly beautiful, and are known as "stamped golds." — *American Builder.*

Paper has been used as a wall covering by the Chinese from time immemorial. It was introduced in Europe, as a substitute for the ancient tapestry hangings, by the French, among whom its manufacture has always been a prominent industry. Paris contains numerous factories, employing over 3,000 workmen, and several large establishments exist in the southern cities of France.

In New York City three factories are in operation. Philadelphia has six, producing annually paper hangings to the value of $800,000.

Wall paper is prepared in several different ways. The cheap varieties are rapidly printed by ingenious machinery, but for the more elegant and elaborate patterns hand-labor is almost invariably used. The paper is procured by the manufacturer in large endless rolls, weighing some 80 to 85 lbs. each. In this condition, if of fine quality, it costs about 17 cents per pound; if ordinary or cheap, the price fluctuates according to the market.

The designs to be printed are prepared as follows: Sketches of the different patterns are made in this country by artists employed for the purpose. These, on being approved, are forwarded to France, where elaborate drawings are made from them. Each color entering into the design must be printed separately, so that there must necessarily be as many blocks or types prepared to make the impressions as there are tints in the pattern. The blocks are constructed of two layers of wood, a thin piece of maple fastened to a thicker backing of pine board. Each block is about 20″ wide, 2′ long and 1½″ to 2″ in thickness. On the maple, all of the design to be printed in a single color is drawn and afterwards cut out by engravers, or rather wood carvers, so that the lines are left in high relief. When the carving is completed, the work is brushed over with boiled oil, and, when dry, sent to the printer for use.

The paint employed for coloring the paper is ground color mixed with warm size and passed through several sieves so that it is rendered perfectly smooth and free from lumps.

The design being decided upon, the block carved, and the paint mixed, the first process the paper has to undergo is its uniform covering with a ground tint. This is effected by passing the paper over an endless rubber belt working on rollers. A copper cylinder at one end of the machine used for the purpose rotates in a box of prepared color. From the cylinder, the paint is distributed to revolving brushes, by which it is applied to the paper passing over the belt. As the paper issues from the machine it is drawn out along the loft and then hung up, in festoons over sticks resting on long frames, to dry. It is then wound on a large reel from which it is cut by boys into pieces of eight yards in length.

In case a pattern resembling oak wood is to be applied to the paper, another machine is employed. The paper is passed around a large cylinder, receiving an impression resembling the grain of oak from a smaller revolving wooden cylinder, which is suitably engraved and covered with the proper colored paint.

The rolls of paper, as they are wound by the boys from the large reel, are sent to a workshop below, where they are stamped with the patterns. This process is done by hand. The workman stands before a table over which passes the paper. Hanging above the table, supported by an india-rubber cord, is the block on which the design is carved. The upper end of the rubber cord is attached to a small wheel traveling on an iron guide, so that the block may be swung from the table over to the place where it receives its covering of color.

The method of making the impression is very simple. The paint is obtained from what is termed the "slush box," which consists of a shallow box, the bottom of which is covered with painted ticking made water-tight. This box floats on water contained in a larger box, so that its bottom is always perfectly level. Inside of the first mentioned box is placed a piece of woolen cloth on which the paint is uniformly distributed. The workman first places the paper across his table, then swings the block over to the slush box, and brings its carved side down on the paint. Next he carries the block back again, and places it on the paper, of course using great care in the registering so that the impression may fall exactly on the right place. A vertical movable arm attached to a frame above is now rested upon the back of the block, and forced down by means of a lever worked by the foot of the operator, thus completing the impression. This process is repeated until the whole piece is covered with the pattern, when it is hung up for from five to ten days until perfectly dry.

If the design is to be gilded, the parts which are to receive the gold leaf are printed in the same manner as above described, only glue size is used instead of paint in the impression. Gold leaf is afterwards applied by girls in the ordinary method.

Satin papers are sometimes prepared by mixing with the coloring matter sulphate of alumina and finishing off with a brush. Velvet or flock paper resembling velvet plush is made after printing the colors, by fixing to the surface some finely ground fibers of wool of the proper hue, by means of glue or white lead and oil.

Paper after being printed is also often embossed by being passed between steel rollers on which a design has been engraved.

The great care which is exerted in printing the many tints of the more elaborate decorations has rendered hand labor necessary in place of machine power; but the expense of producing the material has of course been proportionally increased. Large quantities of the finer qualities of hangings are imported hither from France, but it is a well-known fact that much that is represented as of French manufacture is in reality made in just such establishments and by the same processes as above described.

Of late paper has been printed in patterns which have been suitable for theatrical scenery. At Booth's theater, several of the handsomest scenes are thus made, while in Wallack's the decoration of the entire auditorium is in paper.

In price the fine grades of wall paper vary according to quality, but average from 25 cents to $4.50 per roll of 8 yards.

Paper is extensively used in Japanese houses as a substitute for glass in the windows and sliding doors, and possesses not only the advantage of an immunity from breakage by the frequent earthquakes, but also occasions only a small loss when the house burns down, which happens often enough. Whatever may be its drawbacks, the use of paper for the above purpose is intimately connected with the system of house building in Japan; and it will be long before it is entirely abandoned.

Wall papers are used in all the houses, and are manufactured, not in rolls, but in small sheets ornamented with all kinds of designs printed from wooden blocks, on which the pattern has been cut in relief. The colors having been mixed with some thickening paste, are applied to the block, either by means of a brush or by tamping; after which the paper sheet is laid on the block and rubbed with a flat rubber lined with the smooth bud-scales of bamboo, and used like a printer's ball. Very fine white mica powder is applied to the wall paper, and produces a metallic luster resembling silver.

The crape-paper, which is a most perfect imitation of the real crape, is made by a very ingenious and most simple process. In the first place, that which may be called the matrix-paper is prepared by laying a moistened sheet of strong paper on a wooden board cut with fine grooves, running parallel or crossing one another at very small angles, and by beating it with hard brushes, so as to force it into these grooves. It is then painted over with the frequently mentioned "shibu," in consequence of which operation the paper becomes so elastic that when let go after having been stretched out, it refolds itself. For the production of crape, several sheets of thin moistened paper are laid, alternately with sheets of the above-mentioned matrix-paper, one upon the other. The package is then wound on to a round piece of wood, and pressed several times with a strong lever, as if it were to be stripped off from this piece of wood. By means of this operation, the soft and moistened paper is forced into the folds of the matrix, and consequently folded in a similar manner. By repeating this manipulation 10 or 12 times, each time unrolling it in order to change the position of the paper between the sheets of matrix-paper, and by winding it again on the piece of wood, the paper becomes gradually folded in all directions, the intersecting points of all these folds producing the craped surface. Naturally, this process causes the paper to shrink considerably. This kind of craping is done with printed pictures, and also with colored papers, which are used for coiffures.

The paper imitations of leather are made in the same manner, but of stronger paper. After it has been craped, it is

beaten with hard brushes into the molds which produce the relief patterns; and these designs are afterwards painted as required, with the help of "shibu," or the "Ye-no-abura," and lacquer.

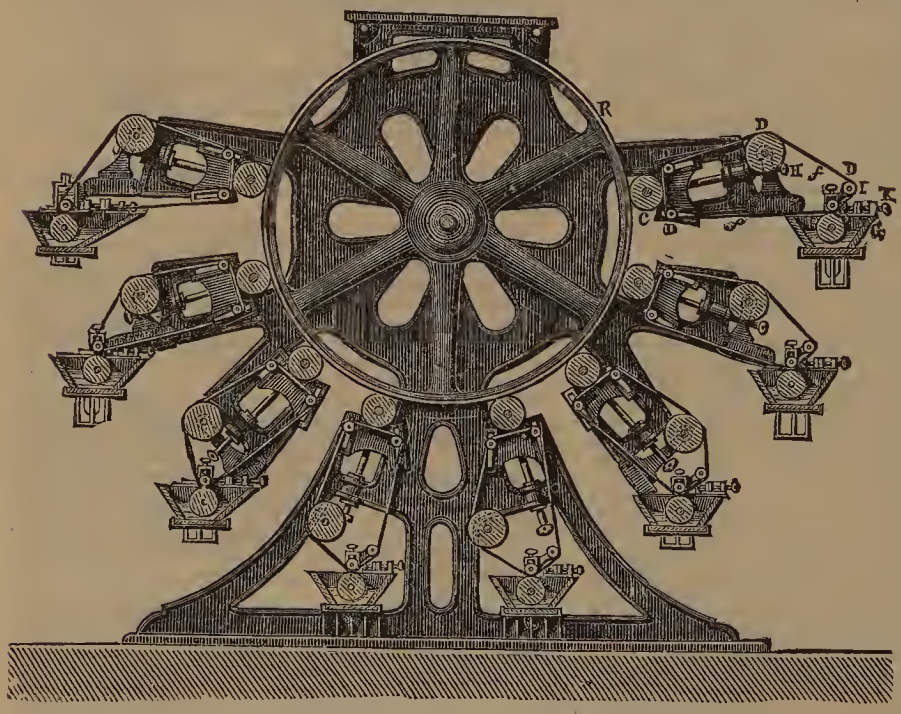
Paper is also often used as a substitute for cloth, for umbrellas, rain-coats, etc., and even for dress cloth. "Shibu," and the "Ye-no-abura," are the means employed for rendering the paper waterproof. This cloth is generally made of paper alone, by beating it to make it soft, and impregnating it with gummy substances, to make it more resistant to the action of water. Another kind of cloth, called "shifu," consists of silk warp and paper woof. The paper is cut into fine strips, twisted together into threads, and spooled for weaving. Paper strings, of great regularity, great strength, and prettily colored, are made in a similar manner, and were formerly used in large quantities for tying up the hair. They are now only used for tying presents and other small parcels.

A veneered wall paper is also made. The wood is cut to the thickness of paper, and by a peculiar process stuck on the paper, which serves as a protection against the influence of the walls on the graining and color of the wood. The delicacy of the machinery employed in cutting so thin a veneer may be gathered from the fact that 200 leaves are cut out of an inch of white maple wood, and 125 out of wood with very open grain, such as oak and walnut.

Wall Pa'per Ma-chine'.

Wall paper machines, printing from cylinders, were made successful by Zuber, of Reixheim, near Mulhouse, about 1832. Rising from the number of 2 or 3 cylinders, they have attained as great a number as 20, printing in as many grounds, colors, or shades. The machine of Gadd, of Manchester, having 8 cylinders, will, however, give as accurate an idea of the construction as one possessing a larger number. It is shown in longitudinal vertical section in Fig. 2523, and works equally well as a calico printer or wall-paper printer.

Fig. 2523.



Gadd's Wall-paper Printing Machine (*English*).

Great difficulty occurred in working machines in which the printing cylinders were driven by gearing, as it was necessary to preserve scrupulous exactness in the sizes of the printing rollers in order to secure correct registry of the parts which combined to form the pattern. In the Gadd machine this difficulty has been met by moving the printing rollers by surface contact.

The central driving cylinder *R*, which forms the platen at the back of the continuous paper sheet, whose other side is exposed to the printing rollers *C*, is mounted upon interior arms or spokes whose hub has a bearing upon the central axis to which the driving power is applied. The printing rollers *C*, engraved in relief, are driven by contact with cylinder *R*, and receive their color from an endless felt cloth *f*, which is distended by interior wooden rollers *D D*. Eight groups of inking and printing devices are arranged about 220° of the perimeter of the driving platen cylinder *R*, but a description of one answers for each of the others, as the action of each is similar, each having its part to perform in adding its quota of color to make up the design which is the sum of contributions of each of the series.

The felt cloth, at its lowest position, is pressed by a roller against the color-feeding roller which revolves in the copper color-trough *G*; the pressure is adjusted by small hand-screws above. Two tension rollers, *D D*, are placed near the surface of the large cylinder and are moved between slides by means of a screw, *H*, so that the felt cloth is pressed against the graven printing roller with the required force. In leaving the inking roller, the felt passes against a *doctor* which removes superfluous color. The screw *K* regulates the *doctor*.

Printing rollers engraved in intaglio, similar to those used in printing tissues, are suitable for some descriptions of wall paper, but little charged with color, for delicate designs and for spotted cards.

For printing striped papers a machine has a reservoir composed of as many compartments as bands are required on the endless web of paper. Each compartment is pierced with an opening at bottom, as wide as the width of band required, the whole forming a series of stripes upon the paper traversing beneath, much as, so far as the paper is concerned, paper ruled with wide striping pens on the paper-ruling machines. Figs. 4499, 4500, p. 2002, "*Mech. Dict.*"

The drying of the paper was formerly done by suspending it from rods in a frame, the piece or bolt occupying 2 of these rods. The wall paper sticking machine of J. & E. Waldron, of New Brunswick, N. J., shown at the Centennial, is a great advance upon hand methods. It places the fold of the paper upon the rod which traverses along a lengthy frame, the rods being automatically supplied, adjusted, and the paper hung thereon and then traversed along the frame, and then returns, doubling the length of time of drying exposure within given limits to the length of the machine.

See view of wall paper printing machine, "*Scientific American*," xxxvii. 223.

Other machines in the manufacture of wall paper are the —

Grounding machine, for putting on the body color.

Sticking machine, for hanging the paper in festoons to dry.

Polishing machine, for giving a satin finish to the ground color to be overlaid by the dead color pattern.

Trimmer, for trimming the edge of the paper, *Boust*, * "*Scientific American*," xxxiv. 230.

Wall Pa'per Pol'ish-ing Ma-chine. A machine for giving a satin finish to wall paper.

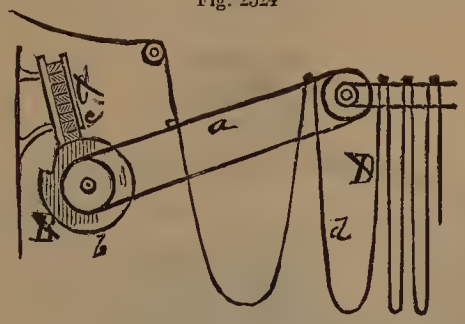
It consists of a central rotating brush against which the paper is repeatedly carried by rotating cylinders. The polish is upon the surface of alumina and oil which is known as the *grounding*.

The printed pattern is usually laid on this in dead color.

Wall Pa'per Stick'ing Ma-chine'. A machine for hanging wall paper in festoons to dry.

The paper from the grounding or the printing machine is conducted between endless belts across which sticks are laid automatically and over which sticks the paper is suspended in festoons. The sticks are so placed that a length of paper measuring just four yards hangs between any two. The belts are kept in constant motion, and, by means of the second belt, the paper is thus conducted along the loft, which measures some 160′ in length. Steam coils are placed beneath the belts, and a temperature of 120° F. maintained. About nine minutes are occupied by any one festoon of paper in making the journey from the grounding machine to the point where

Fig. 2524



Wall Paper Sticking Machine.

it is again made into a roll, and during this period it becomes thoroughly dried.

The device employed for placing the sticks under the paper is represented in Fig. 2524. At the ends of the roller over which the endless belt *a* passes, are two cams, one of which is shown at *b*. Above the cams and resting on their periphery is a pile of sticks, *c*. The cam shoulder equals in height the thickness of one stick. Hence at each revolution of the cam a stick is moved from the bottom of the pile and carried down on and across the belts. Between the latter comes the paper *d*, which thus falls in folds over the sticks as they are laid in place.

Walls. (*Mining.*) The sides next to the lode.

Wall Scra'per. A broad chisel-edged tool with a socket in which can be inserted handles of various lengths for scraping and preparing walls for papering.

Warp'ing. (*Nautical.*) To move a vessel from one place to another by warps, which are attached to buoys, other ships, anchors, bollards on shore, etc.

Warp'ing Ma-chine'. (*Weaving.*) A machine for laying out the threads of the warp and winding them on the warp roller. The spindles containing the threads turn in bearings in the uprights of the frame, and the threads are carried through a separator and between two rollers, by which they are laid out flat and parallel, and are finally wound upon a roller journaled in the arms and resting upon the drum by which it is turned.

Warping, scouring, sizing, drying, and beaming machine. *Leach & Sons*, Engl. * "*Scientific American Sup.*," 1991.

Wash'-ba-sin Valve. A valve for wash basins, by means of which the sewer pipe is claimed to be as effectually closed as the water pipe ordinarily is, and that consequently no sewer gas can escape into the room. The valve being air tight, a partial vacuum is produced above the water trap, which prevents the rush of water through waste pipes below, siphoning the water out of the trap. The construction is also such that the valve cannot be left open when the water is turned off or left shut when the latter is turned on.

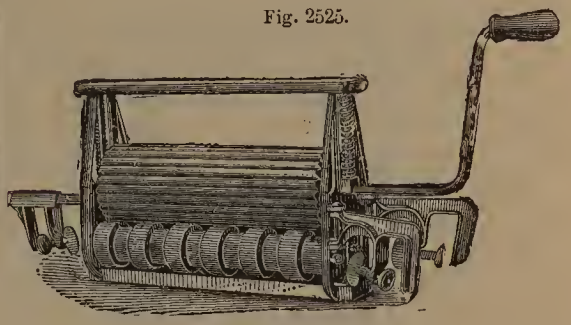
The valve is hinged to the rim of the basin, is made hollow, and of such a weight that as the water rises in the basin it is raised, and the holes covered are so opened that the overflow water may freely escape. The lower surface of the valve is covered with leather, rubber, or similar material, to cause it to cover the overflow holes tightly.

Wash'burn Wheel. A cast-iron car-wheel, designed and patented by Nathan Washburn in 1850. It consists of two plates, which extend from the hub to about half the distance between it and the rim. There they unite into one plate which extends to the rim. The plates are all curved so as to contract when the wheels are cooled without danger of fracturing the wheel. The single plate and the rim are united together and strengthened by curved ribs cast on the inside of the wheel.

Wash'er. The "*Pharmaceut. Centralhalle*" says that, for the purpose of packing joints which are to be hermetically sealed, such as retort connections, couplings, etc., where vulcanized rubber has usually been employed, cellulose appears to be even a better material. It has the advantage of cheapness, it readily absorbs water at first, thereby becoming pliable, and adapts itself more accurately to the surfaces which it is intended to render tight. If a joint is exposed to steam, and is to be frequently opened, the cellulose should be soaked in oil.

Wash'er, Clothes. The Keystone washer, Fig. 2525, has its frame and rollers so arranged that the machine can be attached to the ordinary tub. The washing is done by the united pressure

Fig. 2525.



Keystone Washer.

and friction of the corrugated and ribbed rollers between which the clothes have to pass. A lively pressure is insured by the spiral springs above.

Wash'er, Smoke. Two of the latest contributions to the abatement of the smoke nuisance employ water to wash the smoke as it passes through the flue of the chimney.

The more simple of the two consists of a spray or shower of water driven upward in the chimney flue. The water cleans the smoke of much of its impurities, and falling back escapes below. The blackened water is afterward collected, and under proper treatment yields a coloring material for a fine black paint. The other apparatus is more complicated. It consists of an upright cylinder of boiler plates 14′ high and 5′ in diameter. Inside are a number of sheet iron diaphragms placed one over another, and partly filling the interior. Each diaphragm overlaps the other, and all are perforated with a great number of holes 0.2 of an inch in diameter. The smoke enters below, and a stream of water flows in at the top. The water drips in a shower through the holes, and by the aid of a powerful exhaust, the smoke is forced upward through the apparatus. On its passage, owing to the obstructions caused by the diaphragms, the smoke travels 51′ and is perfectly cleared of soot. The experiments made with this apparatus go to show that the value of such devices depends chiefly on the power of the exhaust or draft, the distance traveled by the smoke through the shower of water, and the perfect subdivision of the water. The amount of water employed seems to be of less consequence.

Wash'er Scrub'ber. The "Standard," washer scrubber consists of a series of cast-iron sections, varying in number with the capacity of the machine. A shaft passes horizontally through the center of these chambers, and is connected at one end with a small engine, or suitable gearing, which furnishes motive power. Each section, with the exception of the two at the ends, contains a number of circular sheet-iron disks which are bolted together and securely keyed to the shaft; indentations in the disks serving to preserve $\frac{1}{4}''$ distance between them. Water at the rate of about twelve (U. S. standard) gallons per ton of coal carbonized, is admitted at one end of the machine, and after passing through the intermediate chambers, and constantly increasing in strength, is drawn off at the other end of the washer. The central shaft is revolved from four to five turns per minute, and the circular sheet iron disks rotate with it, the lower halves being constantly immersed in the water while

the upper portions always present a thoroughly wetted surface for the absorption of the ammonia as the gas passes through.

Wash'ing Fur'nace. The "Pernot" is a regenerative gas furnace, and has a revolving hearth of 12′ × 3′. The four regenerator chambers have 780 cubic feet capacity. The lining is 13″ thick on the sides and 9″ on the bottom, thus giving a hearth 9′ 10″ × 2′ 3″ deep. The lining is composed of lumps of highly refractory ores, roughly fitted together, the interstices being filled with fine ores, and the whole being glazed at a melting temperature. As the ore melts the lining is refilled until the mass becomes monolithic. The hearth is then fettled.

Wash'ing Rol'lers. For squeezing goods or yarn after being scoured.

Two cast-iron rollers turned perfectly true and smooth, are carried on two cast-iron standards; the pressure is obtained by compound levers with movable weights.

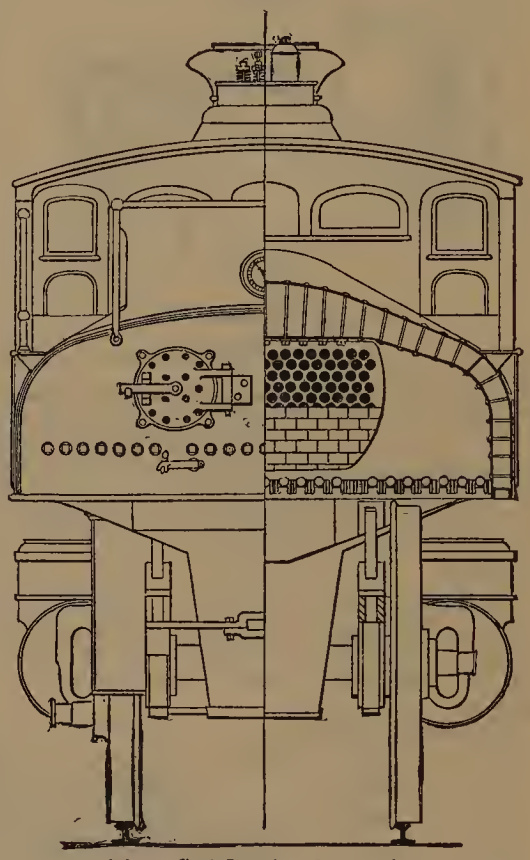
The bearings are of gun metal.

Wash Tub Waste. A stop valve that on removal allows the waste of the wash tub to escape.

Waste Card. A machine for working up and carding the waste, fluff, and broken fiber, that gathers on the floor of the factory.

Waste Coal Burn'ing Lo'co-mo'tive. The Wootten locomotive, Plates LIV. and LV., and Fig. 2526, is especially adapted to the consumption of waste coal, being unique in the large surface area of its grates. It is especially adapted to fast passenger service, by its free steaming qualities, its capacity being equal to the evaporation of 55 gallons of water per minute, enabling it to steadily maintain its speed.

Fig. 2526.



Waste Coal Burning Locomotive.

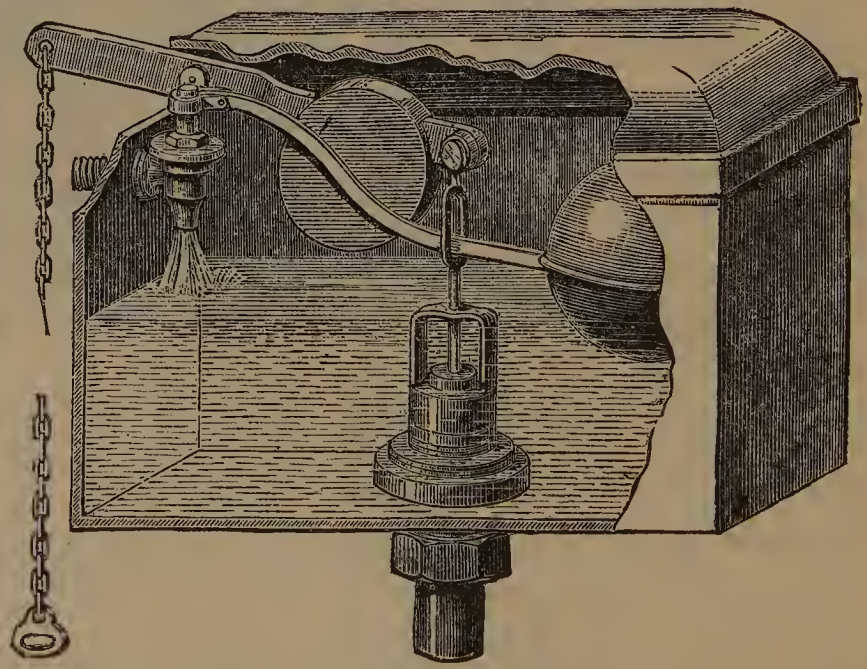
This result is secured by the peculiar form of furnace employed, by which although waste anthracite can be used as fuel with good results as far as steaming is concerned, yet the rapidity of the exhaust emissions is such as to lead to the discharge from the stack of the finer particles of impurities, contained in the waste coal. But notwithstanding its capacity, in consequence of the passenger service in which it is employed, the smaller sizes of prepared coal are used, so it would be a misnomer to class it as a dirt burner.

By reason of the moderate draft of these furnaces, and the consequent economy of combustion of fuel, they are enabled to attain an evaporative effect equal to 60 per cent. of the theoretical evaporative power of the fuel used, whether it be anthracite, bituminous, or lignite.

Waste Pick'er. See RAG PICKER.

Waste Pre-vent'er. Stone's positive waste preventer for cisterns, Fig. 2527, is so constructed that, although only possessing one inlet valve and one discharge valve, it yet answers the purpose of a double-chambered cistern. When the water is required to be drawn off from the cistern the inlet valve leading from the source of supply is closed before the discharge valve can be opened.

Fig. 2527.



Waste Preventer for Cisterns.

The valve is attached to the lower end of a socket in which the valve stem, which is connected at its upper end to the ball stem, is allowed to slide up and down a certain distance freely, so as not in any way to affect the valve; but as soon as the required distance is traversed, the valve stem acts upon the socket, and so causes the valve to be governed by the rising and falling of the ball. When the water from the source of supply flows into the cistern, it raises the ball, and gradually closes the valve until it reaches a certain point, when the pressure on the back of the valve forces it on to its seat, and holds it there, while by means of the

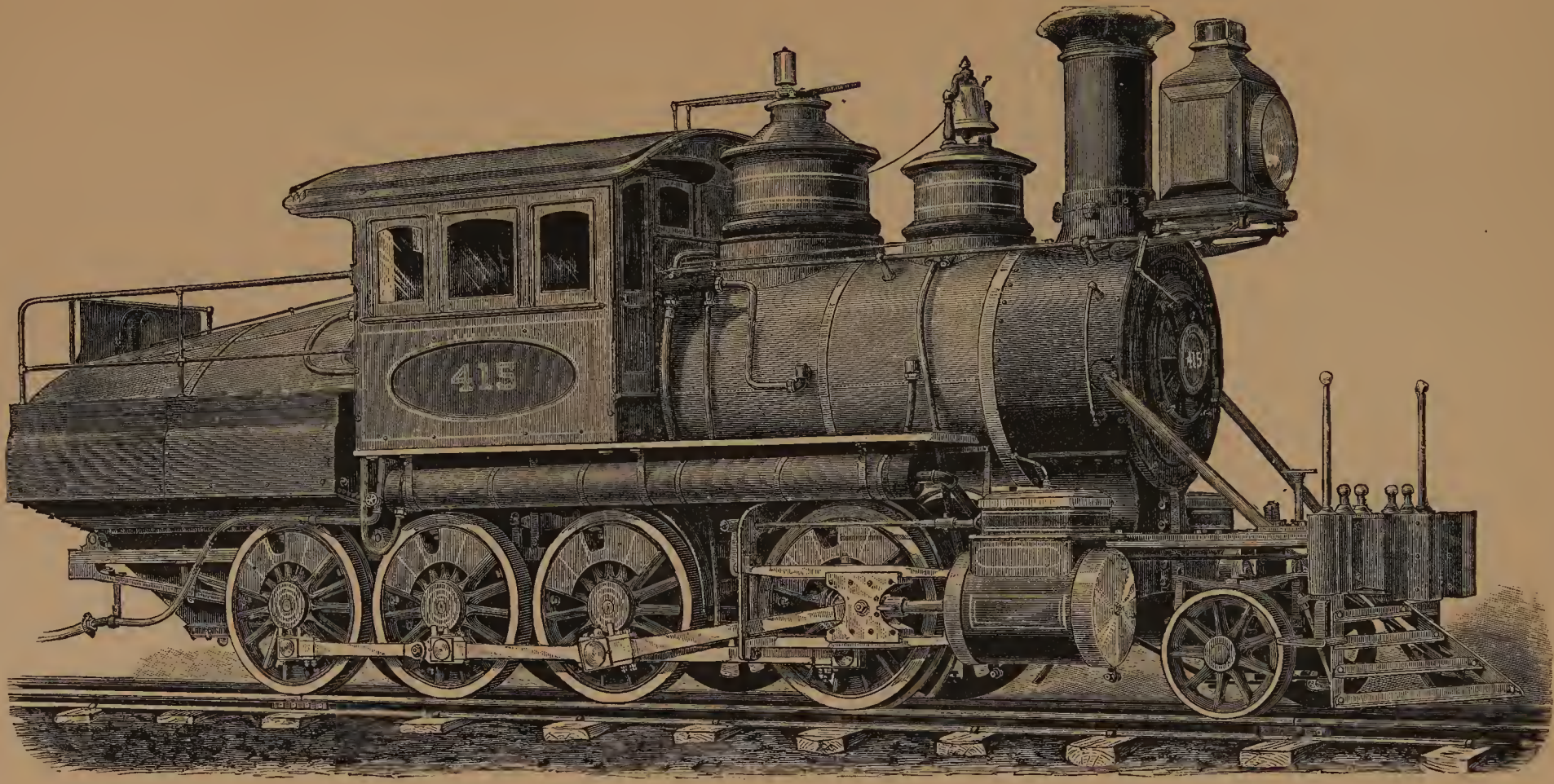


PLATE LIV. WASTE COAL BURNING LOCOMOTIVE.

See page 936.

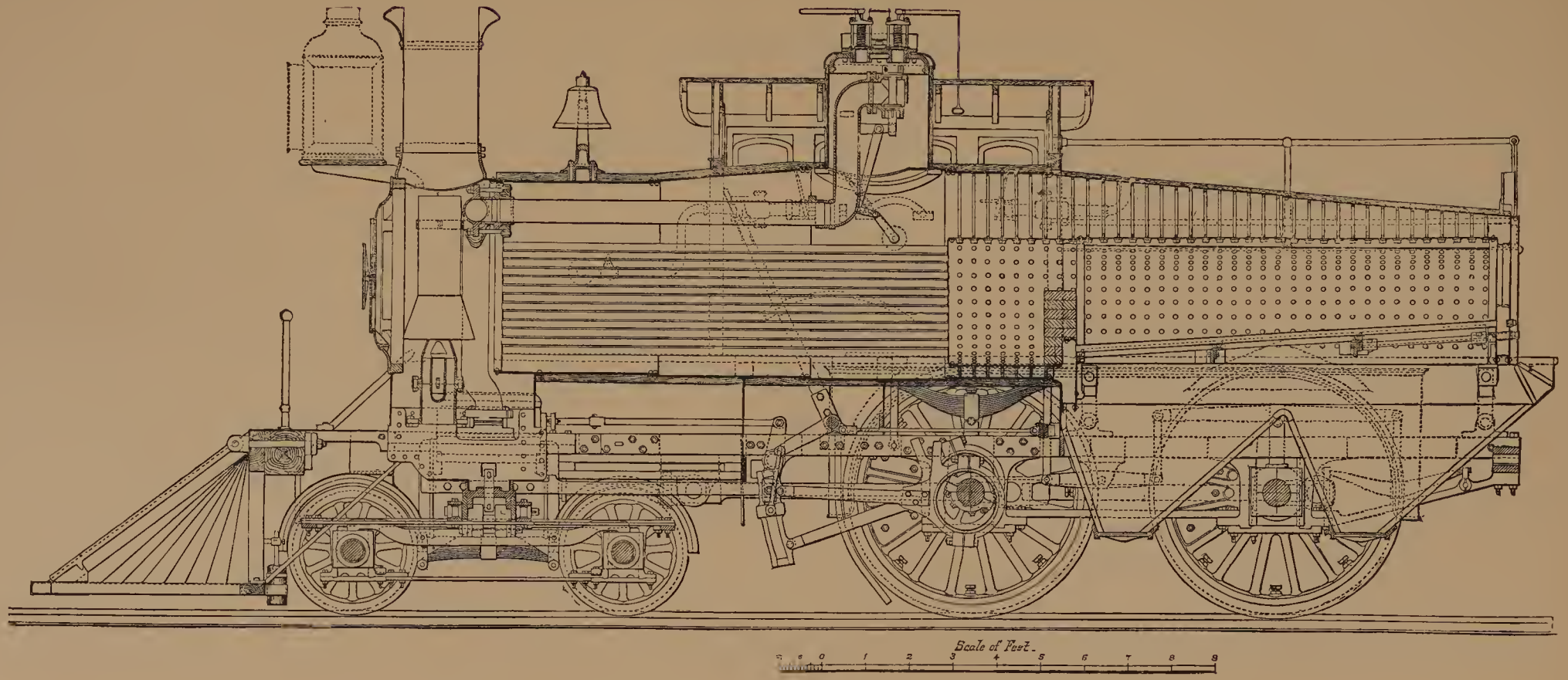


PLATE LV.

WASTE COAL BURNING LOCOMOTIVE. (SECTIONAL VIEW.)

See page 936.

sliding socket, the ball stem can be raised sufficiently high to allow the discharge valve to be opened, so that the water can run out only after the ball valve is perfectly closed.

Or when the lever is pulled and the discharge valve opened, the ball stem and ball are raised at the same time, which can readily be done by means of the sliding socket without affecting the inlet valve, which is held fast on its seat by the pressure of water from the source of supply, as already described. As soon as the water has run out of the cistern, and the lever or pull is let go, the discharge valve is closed, and the ball stem and ball drop, thus opening the inlet valve, and allowing the water to refill the cistern ready for use again.

Watch. Sir Edmund Beckett, a scientific horologist, who is, perhaps, the highest English authority upon the subject, in his work upon "*Watches, Clocks, and Bells,*" says: —

"The liability of a watch, like any other piece of mechanism, to require repair, is in the ratio of the number of separate parts which make up its unity. The English watch, with its fusee and chain, is composed of 638 more pieces than the American watch. Dispense with these 638 additional chances of breakage, and it is easy to infer the superiority of American watches, in this one respect at least. The fusee and chain are rejected in the Waltham watch, and the direct action of the mainspring adopted, because the fusee and chain add greatly to the cost and liability to injury of a watch, and are of no practical value for good time-keeping. This change is advocated on the ground that there is greater simplicity of action, less friction in the transmission of motive power, increased facility for using a lighter and more uniform spring, and more room for play in the other parts of the movements."

In support of this view, Sir Edmund Beckett speaks very favorably of the American principle of omitting the chain. After alluding to what he calls the mischievous and common accidents of chain-breaking, and noting the tendency of advanced watch-making to do without fusee and chain, he says: "Accordingly, both in Switzerland and America, which are gradually stealing away our common watch trade, the fusee and the chain are almost universally omitted."

Dr. Hooke raised horology from a mechanical art to a science by propounding its laws and enriching it with valuable discoveries and inventions.

The discovery and application of the laws of isochronism in the balance-spring by Dr. Hooke and Arnold in England, Leroy and Berthond in France, imparted the most essential quality for keeping a regular rate of time to the chronometer.

"*Isochronism* is an inherent property of the balance-spring, depending entirely upon the ratio of the spring's tension, following the proportion of the arcs of inflexion. A balance-spring, therefore, of any force whatever, having the progression required by the law of isochronism, will preserve this quality, whether it be applied to a balance making rapid or slow vibrations.

"The great advantage of an isochronal spring is its innate power of resisting the influences which cause a change of rate, such as change of position, increased friction as the works become dirty, or the viscidity of the oil at low temperatures." — *Carpenter.*

See list under CLOCK for exhibits of all horological instruments, from *Prof. Watson's* report in "*Centennial Exhibition Reports,*" Group XXV., vol. vii.

See also *Dr. Knight's* report, vol. iv., "*Paris Exposition* (1878) *Reports,*" p. 403, *et seq.*

Dr. Knight's report on watch-making machine at Waltham, is in "*Centennial Exhibition Reports,*" vol. vii., Group XXII., p. 46, *et seq.*

The "*Journal de Genève,*" of August 26th, has the following: The watch-making population of the several Swiss cantons may be held as exactly represented by the subjoined table, compiled from the returns of the census for the year 1870: —

CANTONS.	Men.	Women.	Total.
Neufchâtel	11,081	5,383	16,464
Berne	6,392	4,743	14,135
Vaud	2,439	1,313	3,752
Geneva	5,330	1,288	3,618
Total	25,242	12,727	37,969

Berne is the canton in which there has been the greatest rise in the manufacture of watches of late years. It is computed to produce 500,000 watches a year; and, as they are almost exclusively of ordinary quality, their average value may be set down at 40 francs, which would bring up the total of Bernese annual production to 20,000,000 francs ($5,000,000).

Geneva does not supply much over 150,000 watches yearly, but, as eleven twelfths of these are gold, and in part richly ornamented, their value does not probably fall short of 20,000,000 francs.

The canton of Vaud also turns out 150,000 watches per annum, the works of which are generally highly finished; but then they are in great measure exported without cases, as mere works, the average price being about 35 francs, and the total value being 8,000,000 francs.

Besides these, the canton of Vaud furnishes 80,000 musical boxes, which amount to 8,000,000 francs.

In respect to value, Neufchâtel produces nearly half of the entire Swiss watch-making (35 per cent.); the cantons of Geneva and Berne come in for 23 per cent. each, and the canton of Vaud for 9 per cent.

Break-circuit. *Davidson* * "*Min. & Sc. Press,*" xxxiv. 361.
Watches, American, *Watson* . . . . . "*Van Nostrand's Mag.,*" xvii. 161.
Watch-making, American, on, *Grosjean*, Switz. . "*Min. & Sc. Press,*" xxxiv. 154.
Watch, demagnetizing . * "*Scientific American,*" xli. 227.
Watches, demagnetizing "*Scientific American,*" xxxiv. 23.
Invention and history "*Sc. Amer.,*" xxxvii. 88, 101, 121.
Watchmaker's lathe, *Williams* . . . . . "*Scientific Amer.,*" xxxiv. 194.

Watch'ma-ker's Slide Rest. A slide-rest to a watchmaker's lathe, adjustable by its set screws, to any angle or position that the work requires.

Watch Tel'e-phone. (*Electricity.*) An instrument which takes its name from its resemblance in form to an old-fashioned watch. Invented by Alfred Niaudet-Begnet, of Paris. It is a Bell telephone in which the magnet is bent into a circular form, and the coil is seated upon one of its poles, the planer of the magnet, coil, and diaphragm being all parallel to each other.

Wa'ter A'er-a-ting Ap'pa-ra'tus. A device for aërating the water supplied to an aquarium. The apparatus is an application of the principle of the "Catalan trumpet" that is used to operate the bellows in the iron furnaces of Spain. It consists of a number of glass tubes, into which the water is forced by hydraulic pressure, carrying with it bubbles of air, the presence and movement of which in the tubes may be plainly seen.

Wa'ter A-nal'y-sis Ap'pa-ra'tus. McLeod's water analysis apparatus, used to determine the purity of drinking water, is an improvement of the one described by Dr. Frankland and Mr. Ward, by which temperature and tensions of fixed volumes of water and gas are tested. This instrument is very much in use. It consists of a measuring tube 900 mm. in length and about 20 mm. in diameter, which is marked with ten divisions, the first at 25 mm. from the top, the second at 50 mm., the third at 100 mm., and the remaining ones at the intervals of 100 mm.

In the upper part of the tube, platinum wires are sealed, and it is terminated by a capillary tube and fine glass stop-cock, the capillary tube being bent at right angles at 50 mm. above the junction. At the bottom of the tube a wide glass stop-cock is sealed, which communicates, by means of a caoutchouc joint surrounded with tape and well wired to the tubes, with a branch from the barometer-tube. At the upper extremity a glass stop-cock is joined, the lower end being curved and connected by caoutchouc with a stop-cock and tube descending through the table to a distance of 900 mm. below the joint. The two tubes are firmly held by a clamp, on which rests a wide cylinder, about 55 mm. in diameter, surrounding the tubes, and adapted to them by a water-tight caoutchouc cork. The cylinder is maintained in an upright position by a support at its upper end, sliding on the same rod as the clamp. Around the upper part of the barometer-tube a syphon is fixed by means of a perforated cork, through which the stop-cock passes. A small bulb-tube, containing some mercury, is also fitted in this cork, so as to allow of the air being entirely removed from the syphon. The syphon descends about 100 mm. within the cylinder, and has a branch at the top communicating by caoutchouc with a bent tube contained in a wider one affixed to the support. A constant current of water is supplied to the cylinder through a

glass tube, which passes to the bottom, and escapes through the syphon and tubes to the drain. To the end of the narrow tube is fastened a long piece of caoutchouc tube, covered with tape, by which a communication is established with the mercurial reservoir, suspended by a cord, so that by means of the winch it may be raised above the level of the top of the barometer-tube.

Wa'ter Bal'last. A mode of ballasting vessels with water, in tight compartments in the bottom of the hull.

Wa'ter Bar'rel Truck. A pivoted water-barrel mounted on wheels, and drawn by hand. The barrel, being pivoted by its spindles, is easily emptied.

Water ballast, on,
Martel (20 Figs.) . . * "*Engineer*," xliv. 174.
Construction . . . * "*Engineering*," xxiv. 186.

Wa'ter Bear'ing. Shaw's water bearing is designed to relieve the pressure on the step of a vertical shaft.

It consists of a disk secured to the shaft, and provided with a circular piston. The water entering from a pipe under a sufficient head, passes into the chamber of the piston and between it and the lower face of the disk, lifting the latter. If the upward pressure of the water be in excess of that necessary to sustain the shaft and the weight it may have to bear, a portion escapes beneath the lower edge of the piston and the shaft settles to its normal position.

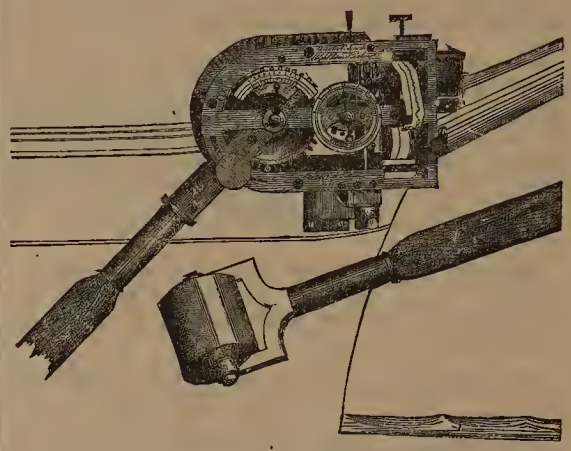
Wa'ter Box. (*Metallurgy.*) An iron box to contain water forming a bottom or side of a furnace in order to prevent it from burning out. Tuyere plates are so protected.

Wa'ter Breast. An improved tuyere for water breasts is described as follows: —

A bronze tuyere is inserted into the end of a water breast, which is bored out conically to receive it, and does not, therefore, call for any packing. The butt end of the tuyere is turned so that it presents a part of a sphere, and the end of the belly pipe is correspondingly shaped to produce a perfect joint. By a simple arrangement, which allows rapid and easy replacement of the tuyere, the movable parts are firmly held together. This is effected by a knee lever under the elbow, at the longer end of which a detachable weight is hung. The pressure exerted by this weight firmly connects water breast and tuyere on the one hand and belly pipe and tuyere on the other. By this means all bolts are done away with, and the weight need only to be removed to allow the different parts to drop apart. When it becomes necessary to replace a tuyere a hook is inserted, and it is readily pulled out. By arranging proper openings at the butt of the tuyere any air entering in the water is trapped and carried off direct by the waste pipe. The discharge pipe is taken off at the top of the tuyere and air prevented from collecting in it. For a short distance outside of it the discharge pipe is elevated, which carries off at once any air or steam bubbles to a higher point outside of the tuyere, thus avoiding danger to it. In order to prevent any water from entering the furnace the water is drawn through the tuyere by suction at the same velocity as if it were forced through. It is claimed that, as by this means the water pressure is brought down below the atmospheric pressure, which is generally smaller than that of the blast in the interior of the furnace, no leakage in consequence of cracks can take place. It was found also by experiment that drawing the water through the tuyere prevents any accumulation of air or steam bubbles, the steady growth of which will ultimately lead to cracking. Great though the advantages of suction may be, however, its use is not a necessary element in the application of the tuyere, which, it will be readily understood, works well with pressure also. The nozzle in the tuyere, as it fits into it well, is cooled by the circulation of the water in the latter, and can therefore be carried very near the end of the tuyere, a circumstance which aids the penetrating power of the blast. The nozzle may be easily drawn out through the belly pipe, if the cap on the tuyere pipe elbow is removed. When fire-brick stoves are used the tuyere pipes are made double, in order to prevent the serious loss of heat which otherwise takes place.

Wa'ter Chan'nel In'di-ca'tor. Echebarn's indicator, Fig. 2528, for water channels was designed to indicate and register the depths of water in the Rio da Prala, which, from the continual shifting of its waters, presents great difficulties to navigation. There is a long rod turning on an axle that is provided with a toothed wheel, and bears an index pointer, indicating on a graduated are the inclination of the rod from the horizontal.

Fig. 2528.



Water Channel Indicator.

The lower end of the rod bears a roller that travels on the bottom of the river, or the body to be indicated. A toothed wheel drives a wheel train bearing a paper drum, and on a paper band a pencil describes in miniature the condition of the bottom in the line traversed by the vessel.

Wa'ter Charg'er. A device for retaining a body of water always close to the pump, so that if the lower valve of the pump leaks, and the water all runs out of the suction pipe, or if it has been let back to avoid freezing, this charger will still retain a full supply to be readily sucked into the pump, wetting the valves and packing, so as to at once bring the water, and cause the pump to work freely. The charger should be connected into the suction pipe as near the pump as it can be conveniently, and still be out of the way of frost. This charger also greatly facilitates the working of a pump, particularly where the suction pipe has to be of great length, serving as an air chamber in same.

Wa'ter Col'umn Air Com-pres'sor. One operating by the force of a descending body of water, as in some mines and mountain regions. See AIR COMPRESSOR.

Wa'ter El'e-va-tor. See PUMP.

Water elevator, *Coates* . * "*Scientific American*," xl. 278.
Steam, *Wright* . . . * "*Scientific Amer.*," xxxvi. 274.
By ammoniacal gas . * "*Scientific American Sup.*," 805.
For locomotives.
Haggas, Can. . . . * "*Engineering*," xxviii. 296.

Wa'ter En'gine. Wells' water engine is intended to be used as a motor, and also if desired as a pump. The cylinder is mounted on bearings of the case on trunnions. It has a circular valve formed on the lower end, with one port, and fitted to the correspondingly shaped valve seat in which is the inlet and the exhausts for the waste from the interior of the case. Passages are cored out in the cylinder, from the upper end down to the interior of the waste water case, to conduct the leakage to the discharge through the exhaust.

A cap screws to the top of the cylinder for a guide to the piston rod, and these passages enter the cylinder above the piston, under the cover. The oscillation of the cylinder, in the case, alternately opens the supply and exhaust passages.

Water engine, *Hastie* . * "*Scientific Amer.*," xxxix. 227.
Three-cylinder.
Hastie, Br. . . . * "*Engineer*," xlvi. 146.
Water ejector.
Vaughn, Br . . . * "*Engineer*," xlix. 342.

Wa'ter Gas. Any illuminating gas in whose manufacture the decomposition of water plays a prominent part, as distinguished from the illuminating gas produced solely by the decomposition of bituminous coal, wood, resin, tar, oil, or other like material.

Briefly, the Lowe process is the following: A generator of the ordinary type is filled with fuel brought to a high temperature by the aid of blast. The combustible gases thus formed are carried to a chamber filled with loose fire-brick, called a superheater by the inventor, although it should more properly be termed a regenerator. As soon as by the burning of the generator gases the regenerator has attained a high temperature, the blast is cut off and superheated steam is admitted a little above the grate, and simultaneously small streams of crude petroleum or naphtha are allowed to drop through the current of ascending gases upon the incandescent fuel. The steam is decomposed and hydrogen and carbonic oxide are formed. The products of the decomposition of petroleum, hydrocarbons, pass to the regenerators together with the water gas, where the hydrocarbons are gasified. As soon as the temperature of the generator falls below a certain limit the flow of steam and of petroleum is stopped, fresh coal is charged, and the blast of air turned on again.

Dr. W. H. Wahl gives the following answer to the query, "What is water gas?" "Water gas may be defined to be the gaseous product resulting from the interaction of steam and carbon at a high temperature. Generally speaking, the mode of its manufacture is to pass steam through a thick layer of glowing coal. The result of this procedure will be very easily understood by reference to the following explanation: The glowing coal (carbon) seizes upon the oxygen of the steam, uniting with it to form carbonic acid and liberating hydrogen. The carbonic acid thus formed is, however, obliged to pass through a considerable layer of glowing coal (carbon) before it can escape, and this carbon has so strong an affinity for oxygen that it deprives the carbonic acid of one equivalent of its oxygen, reducing it to the state of a lower oxide of carbon. The product which results from these several reactions is 2 equivalents of hydrogen and 2 equivalents of carbon oxide; or, expressed in chemical terms, $2H + 2CO$. This product is what is known as water gas. It is incorrect to assert that any positive gain in heating effect is obtained by this process, for the energy expended in the process of decomposing the water is precisely equal to the additional heat given out by the combustion of the water gas over what would have resulted from the combustion of the carbon alone. On theoretical grounds, therefore, there can be no economy in the process; but there is a gain in practice, and this is due to the fact that the combustion of a gaseous fuel can always be effected with greater economy in our furnaces, stoves, etc., than that of a solid fuel. The gain, therefore, is to be ascribed to the physical condition of the fuel, and not to any advantage resulting from the chemical reaction that has taken place. This is a very common error and is entertained even by otherwise well-informed persons. We look upon the future of water gas as highly promising. With its aid it is made possible to produce illuminating gas more cheaply than by any other process, by simply enriching it with the vapors of petroleum or of other substances rich in illuminating elements But the grand field of water gas for the future will lie in filling the place of a fuel for industrial and domestic uses to take the place of coal. We think the time is not very remote when water-gas will be distributed to our houses just as coal gas is now distributed, — when coal and wood fires, with their dirt and ashes, will only be known as things of the past."

Water Gas, *Strong* . . "*Van Nostr. Mag.*," xxiii. 376.
On, Prof. Henry Morton "*Plumber & San. Eng.*," ii. 347.
Dwight . . . . . "*Scientific American Sup.*," 948.
Appa., *Lowe & Strong* * "*Engineering*," xxviii. 385.
Lowe . . . . . * "*Iron Age*," xxi., April 11, p. 1.
As a fuel, *Dwight* . . "*Scientific American Sup.*," 836.

Wa'ter Lens. The first microscope in existence consisted of a drop of water. Water lenses as formerly used were unstable and tremulous, and almost if not quite worthless. This difficulty may be overcome, and the drop of water rendered available as a microscope lens by confining it in a cell consisting of a short tube having a glass bottom.

The simplest and cheapest of all microscopes consists of a thin piece of glass, having attached to it one or two short paper tubes, which are coated with black sealing-wax, and cemented to the glass with the same material.

By aid of a small stick water is placed, drop by drop, in the cells until the lenses acquire the desired convexity. Objects held below the glass will be more or less magnified, according to the diameter and convexity of the drop.

An easily made and convenient stand for the water lens is made of wood. The sleeve that supports the table slides freely upon the vertical standard. A wire having a milled head, by which it may be turned, passes through the upper end of the standard, and has wound upon it a strong silk thread, one end of which is tied to a pin projecting from the table supporting sleeve. An elastic rubber band is attached to the lower end of the sleeve, and to a pin projecting from the standard near the base, to draw the table downward. By this device the focus may be nicely adjusted.

Two standards project from the bed-piece for receiving the corners of a rectangular piece of silvered glass which forms the reflector.

The best form of water-cell consists of a brass tube about $\frac{3}{8}''$ long and $\frac{1}{4}''$ to 3-16″ internal diameter, having in one side a screw for displacing the water to render the lens more or less convex. A thin piece of glass is cemented to the lower end of the tube, and the inside of the tube is blackened.

Several bushings may be fitted to the upper end of the tube to reduce the diameter of the drop, and thus increase the magnifying power of the lens.

Water containing animalcules may be placed on the under surface of the glass, and the lens may be focused by turning the adjusting screw. The lens may also be adjusted to magnify objects placed on the movable table.

If air-bubbles form on the upper surface of the glass they may be readily displaced by means of a cambric needle.

Water lens microscope * "*Scientific Amer.*," xxxviii. 258.

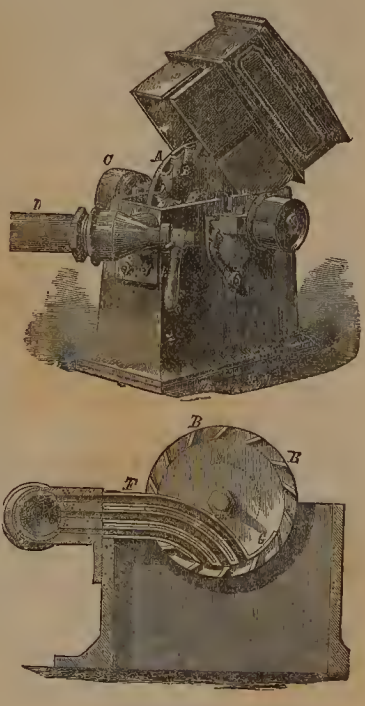
Wa'ter-lev'el Gage. A small bell-shaped casting, into the upper part of which a narrow brass tube, open at the lower end, enters. When the ball is submerged the increase of pressure confined in the bell and the tube will be in proportion to the depth reached. The pressure is indicated on a graduated gage. It will be easily understood that as the pipe may be of any length desired, it is possible to place the gage at quite a distance from the water the depth of which is to be measured.

Wa'ter-lev'el In'di-ca'tor. *Lethuillier-Pinel* (Fr.), * *Laboulaye's* "*Dictionnaire des Arts et Manufactures*," tome iv., ed. 1877.

Water level indica., electric, *Hasler* * "*Teleg. Jour.*," vi. 93.

Wa'ter Mo'tor. The invention herewith illustrated applies water to a wheel of a novel construction, whereby the whole centrifugal force of a jet of water is concentrated on the center of the buckets. From these it is immediately discharged, thus avoiding any friction or dead lift, and imparting to the wheel not only a greater impetus, but, it is claimed, a very high degree of power, considering the pressure and the size of the stream used. Although adapted to all purposes where water is used as a motive power, this invention is more particularly designed for use where the supply of water is limited or variable; and this is believed to be a desideratum, as streams of water are liable to much fluctuation at different seasons of the year. More especially is it designed for use

Fig. 2529.



Water Motor.

in propelling light machinery, such as printing presses, sewing machines, lathes, etc., wherever water can be taken from a hydrant. It is also claimed to be well adapted for heavy work.

The disk of the wheel *A* is made of brass of various sizes, and together with the buckets *B B*, is of a peculiar construction and of a capacity to correspond with the size of the stream and the power required. *C C* are the belt pullcys; *D* the supply pipe; *E* a self-packing faucet or stop-cock, which is the subject of another patent obtained by the same inventor. This faucet is capable of supplying one, two, three, or more streams of water of different dimeusions through the pipes *F*, which are firmly held in positiou at the point of delivery of the water on the buckets by a shoe, *G*. The pipes are provided with bushings at their extremity, which can be removed at pleasure, and others of a different capacity inserted. The waste pipe, of course, can be arranged as required, either from the sides or bottom of the casing. The communication between supply pipe and buckets is shown in section in Fig. 2529.

One of the smallest motors capable of being put to practical use is the Hayworth's miniature turbine water motor. It consists of a tube 3″ long and ⅝″ outside diameter, with an oblique inlet by which it can be screwed to the hydrant or faucet. A small stem with a double pulley at the end projects from the upper end of the tube, and is rapidly revolved when the water is turned on. A rubber hose drawn over the lower end of the tube conveys the water off after performing its duty. By an endless cord the motion can be transmitted from the pulleys to a sewing machine or any other machine requiring only light power for driving. The motor is constructed on the principle of turbine wheels, and can be run with water pressure of 10 to 15 lbs. to the square inch. After entering the tube by the inlet, the water first passes a stationary wheel having a series of radial vanes of such a shape as to give the water a spiral motion. Issuing from these vanes, the water strikes against similar vanes of a wheel that is fastened to the above mentioned spindle, and which, by the impact of the water, is made to rotate.

Different sizes of this motor are manufactured. The smallest size, of the dimensions above stated, furnishes sufficient power to drive sewing machines, etc.

Messrs. W. H. Bailey & Co., of Salford, England, have recently designed a new water motor which works under the ordinary pressure of the water sent through the street mains. In appearance it is somewhat similar to an ordinary horizontal steam engine. It has an oscillating cylinder, with parts so arranged that the motion of the cylinder cuts off the supply of water at the end of the stroke, a reciprocating action being thereby obtained and imparted to the fly-wheel by the ordinary crank arrangements. There are no loose valves or tappets in connection with the motor, and all the fixing it requires may be done by a plumber, as there is nothing more to do than to connect the machine with a pipe from the street main. One of the motors is said to be working very successfully at the bottom of a colliery shaft near Bolton, the power being supplied by the water pumped up from the pit by the steam engine. A large number of laden wagons are drawn up an incline with great ease by this means. The motiou has also been utilized for sawing timber, printing newspapers, etc. — *Iron Age.*

See also Patents: —

Tate, Oct. 31, 1871	No. 120,548.
Backus, Jan. 6, 1874	No. 146,120.
Dobson, Jan. 7, 1873	No. 134,651.
Schmid, Feb. 27, 1872	No. 124,162.
Welch, Dec. 17, 1872	No. 134,115.

See HYDRAULIC PRESSURE ENGINE; WATER PRESSURE ENGINE.

Water motor . . . * "*Scientific American*," XXXV. 150.

Wa'ter Pres'sure En'gine. See HYDRAULIC ENGINE.

Wa'ter-proof Ce-ment'.

Glue	4.
Resin	4.
Red ocher	3, with a little water.

Wa'ter-proof-ing. The Neptunite water-repellent process, owned by the International Chemical Company of New York is founded upon the several patents of Mr. D. M. Lamb. It is applicable to all sorts of textile fabrics: paper, leather, etc., in fact to all goods which it is desirable to protect from the action of water and dampness, and which are liable to mildew and decay.

The effect of the treatment by this process is to render the goods non-absorbent, or water-repellent. The property of capillary attraction possessed by all fibrous goods is destroyed. The pores of each fiber are filled with the Neptunite material and the fiber receives a coating of the same. By the action of heat this is thoroughly incorporated into the fibers, giving them the remarkable properties mentioned.

The action of water upon the fabrics treated is very peculiar. When poured upon the goods the water runs about like quicksilver, without showing any disposition to be absorbed or to penetrate. In the case of open goods like grenadine or even musquito-netting, the water can be made to run about like quicksilver without passing through the open spaces.

The advantages given to the goods are by no means confined to the water-repellent quality. The fibers are made tougher and stronger, and do not crack and disintegrate as before treatment. Goods may be rendered proof against moth and vermin; the colors are imprisoned and fastened; the threads are slightly swelled, giving the goods a firmer and more compact texture. This is peculiarly valuable in the case of silks, giving them a hand and body which cannot be secured except by a large increase of the stock used.

It is well known that rubber waterproof garments are pronounced injurious to health from the fact that they confine the perspiration of the body. In the case of the Neptunite garments, however, the insterstices between the fibers are not closed, and a free circulation of air is permitted, but at the same time a perfect protection from the rain is insured. Ladies' waterproofs are now made from thin mohair goods and these light garments will afford the same protection in ordinary showers as the unsightly rubber goods.

The process is of almost universal application and is of great economic importance. It is at the present time extensively used, and must soon come to a general application throughout the country.

The solution used is a colorless fluid produced by the action of certain gases upon hydrocarbons, and is inexpensive. It is better to treat the goods in the piece before being made up, but ready-made garments can be treated, though they are more expensive to handle in quantities.

Waterproof soles, which are either inserted into ordinary leather soles or laid into the boot, are made as follows: A mixture is prepared, consisting of 60 parts of resin, 80 parts of tallow, 5 parts of wax, and 5 parts of turpentine. In this mixture linen is soaked, and is thereby rendered water-tight. The sheet of linen is then united to a sheet of wool by being passed between rollers. On the linen side the sole is now covered with a solution of glue to prevent the resinous surface from sticking to the stockings and shoes in walking.

To waterproof leather: Melt one liter of boiled linseed oil, 125 grams of suet, 46 grams wax, and 32 grams resin together over a slow fire, and apply it to the leather with a brush while warm. This composition keeps the leather very soft. The English fishermen have long been using it. They can remain in the water for hours ere it penetrates through the leather.

For making canvas waterproof: It is very easy to make canvas waterproof, without altering its appearance or pliability, by saturating it with a boiling and strong solution of soap, pressing out the excess of this, and then submitting it for a short time to the action of a hot bath of alum, sulphate of aluminum, or acetate of lead, which operation causes the formation of an insoluble alumina or lead soap, which will permeate all the pores of the texture and make it waterproof.

To render fabrics waterproof, M. Dujardin proposes the following procedure: 335 grams each of potash, alum, and sugar of lead, are to be triturated in a mortar until the mass becomes syrupy, to which is then to be added 400 grams of a mixture of equal parts of finely pulverized bicarbonate of potassa and sulphate of soda. To this mixture there should now be given about 50 liters (about 11 gallons) of rain water, and when complete solution is effected, the same is poured into a vessel containiug an oleine soap in solution in an equal quantity of water. This mixture is to be stirred for about 20 minutes, or until complete mixture has occurred. To waterproof a fabric it is necessary only to immerse it, with the hand or by mechanical means, into the aforesaid mixture, and to retain it there until by pressure or otherwise the fluid has penetrated to every portion of it. The fabric is then removed, and after allowing the surplus fluid it retains to drop off, hung up to dry. Afterwards it is thoroughly washed in cold water, and again dried. Goods treated in this way, it is affirmed, are waterproof, but still permit free transmission of air. The colors of the goods are in no wise affected. — "*Journal des Fabricants de Papier.*"

Wa'ter-proof Pa'per. Waterproof paper of superior quality, transparent and impervious to fat, may be prepared by saturating good paper with a

liquid prepared by dissolving shellac at a moderate heat in a saturated solution of borax. Paper thus prepared resembles parchment, and may be given any color by the use of aniline dyes.

When a sheet of paper is immersed in an ammoniacal solution of copper and then dried, it is said to become quite impermeable to water, and does not lose this quality even although the water be boiling. Two sheets of paper thus prepared and passed between cylinders adhere to each other so completely as to be quite inseparable. If a large number of sheets so prepared be thus cylindered together, boards of great thickness are obtained, the cohesion and resistance of which may be increased by interposing fibrous matters or cloths. The substance so prepared is quite as hard as the closest-grained wood of the same thickness. The ammoniacal solution of copper is prepared by treating plates of copper with ammonia of the density of 0.880 in contact with the atmosphere.

Wa'ter Sup-ply' for Lo'co-mo'tives. The water tanks of locomotive tenders are usually replenished from elevated tanks at the side of the track, either filled by the natural flow of water from a more elevated source or by means of a pumping engine. In some cases the locomotive itself is caused by suitable connections to operate a pump and draw its own water from a reservoir or well.

Either of these methods involves a stoppage of the train, and to obviate this efforts have been made to render the engine capable of supplying itself with water while in motion.

In 1854 Mr. Angus W. McDonald, of New Creek Depot, Va., patented an invention embracing two different methods of effecting this object.

By one the tank of the tender was to be air-tight, so that after being filled and partially exhausted there would be a partial vacuum within. From the side or bottom of the tank a valved pipe or hose was to be dropped into a cistern of water on or under the road, as the engine passed by, when, the valve being opened, atmospheric pressure would force the water into the tank. The other method was to employ an inclined trough or plane at a suitable angle to dip into the pool of water; the velocity of the train causing the water to ascend into the tank.

The latter plan has since been adopted on some railways. A water-trough of cast-iron sections, 18″ wide at top by 6″ deep, is laid upon the sleepers between the lines of rails at such a level that when full the water surface is 2″ above the level of the rails. A scoop of brass, having a mouth 10″ wide by 2″ high, and turning on a hinge, is, when in normal position, kept elevated by means of a balance weight, but is, when used, depressed, and is kept in this position while the tank is being filled.

The upper end of the scoop and the lower end of the delivery pipe are of corresponding circular arcs, so that the scoop forms a prolongation of the pipe when in position for raising water. The limit to which the scoop may be depressed is adjusted by set screws, and is varied as the brasses and tires of the tender become worn, lowering the level of its body. The trough is cast in lengths of about 6′, so as to rest on each alternate sleeper, and is fixed to the sleepers, its height being adjusted by means of wooden packing. The ends of each length are formed with a shallow groove, made water-tight by round strips of vulcanized rubber, the metal not being in contact. The road at each end is laid with an incline of 1 in 100 for a distance of 16 yards, the trough tapering down to a mere plate to allow the scoop to pass clear in entering and leaving it. At each extremity is an overflow pipe to limit the depth of water to 5″.

The orifice of the scoop is just covered by the water, and its edges are beveled off sharp to diminish splashing. The top edge is carried forward 2″ or 3″, and turned up with the same object. The water rushes into the scoop and up the delivery pipe, which is caused to discharge downwardly in order to prevent splashing.

Wa'ter Thief. A tube for drawing water from a cask, barrel, etc., by the bung-hole. A *bung-bucket.*

Wa'ter Tow'er. A portable stand-pipe for use at fires. This invention of Mr. Logan, a practical machinist of Baltimore, having been brought to the attention of the New York Commissioners they invited an exhibition in that city, and Chief Bates was instructed to furnish every convenience for a thorough test of the apparatus. The test was in every way satisfactory, and all who witnessed the operation of the machine, says the "*Fireman's Journal,*" expressed the opinion that it was a practical and desirable adjunct to fire departments.

The water tower consists of three sections of iron pipe mounted on a truck; these sections being fitted together horizontally are raised to a perpendicular position by turning a wheel, an operation easily performed by one man; at the upper end of the tower is a flexible play-pipe, to which was affixed a 1¼″ nozzle: at the base of the tower are connections for two lines of hose. Engine No. 20 was at a hydrant at Washington Square, and connected to the tower by two lines of hose. When water was first put through the hose, a coupling flew off and had to be sent to the repair shop to be readjusted. Meantime the steamer played through one line of hose, a splendid fire stream being projected through the tower, the nozzle of which was 51′ above the ground. One man on the truck had perfect control of the stream, and by means of a simple gearing was able to depress or elevate the stream, or turn it in any direction, sweeping the horizon at all points and freely sprinkling the promiscuous crowd that had assembled. At a height of 28′ a branch-pipe is placed and two streams were thrown at the same time, being handled with equal ease and facility by one man. Subsequently the tower was lowered and a short section substituted, having a 1½″ nozzle and a height of 37′. Two lines of hose were connected, and two streams thrown from the tower to a great height and a great distance horizontally.

The ease with which the machine was handled and its effectiveness excited the admiration of all beholders. Firemen, especially, were enthusiastic regarding it, but wanted to see one 70′ instead of 50′ high, and a 2″ nozzle substituted for the smaller. The advantages offered by this machine are the getting of a solid stream high in the air before it leaves the nozzle without the aid of ladders, and the ease with which it is controlled by one man. Of course no greater power is exerted than is furnished by the engines, but half a dozen streams could be siamesed into it if necessary. At the test the highest water-pressure obtained was 170 lbs., while the owner claims that the tower will sustain a pressure of 300 lbs. at the nozzle. As Commissioner King remarked, a 2½″ stream delivered at that height under such pressure would be bound to make a black mark on any fire against which it was projected. It would also be of great value in "wetting down" buildings contiguous to a fire, as its range would enable it to sweep both sides of the street and keep the buildings wet from curb to cornice.

Wa'ter Wheel. A wheel turned by the action of water.

Laffineur's "Treatise on the Construction of Water-wheels."
Lowell's "Hydraulics."
Glynn's "Treatise on the Power of Water as applied to drive Flour Mills, and to give motion to Turbines and other Hydrostatic Engines." 12mo. New York, 1869.

Wa'ter Works. For a description of various works for furnishing water supply, see "*Mech. Dict.,*" p. 2746.

See also *Colburn & Maw's "The Water-works of London."*
Jacob's "On the Designing and Construction of Storage Reservoirs." 16mo.
Prof. Corfield's "Water and Water Supply." New York, 1875.
McMaster's "High Masonry Dams."
Kirkwood "On Filtration of River Waters."
Fanning's "Water Supply Engineering."
McElroy's "Papers on Hydraulic Engineering."
Hughes' "Water-works for Cities and Towns." (Weale's Series.) New edition.
Humber's "Comprehensive Treatise on the Water Supply of Cities and Towns." Illustrated.
Haskoll's "Water-works, Sewage, and Irrigation." Being vol. ii. of "*Engineering Field Work.*" London, 1871.

Wave Mold'ing Ma-chine'. The Ransome wave molder has carriage, feed, and reciprocating scraping cutters. The chisel bar or its connections are elongated to give the stroke, the bar and chisel having a reciprocating motion, but capable of being extended to the depth of the mortise, and yet resisting in its joints the force of the blow.

Wax. The following are some useful recipes for sealing wax: —

Red Sealing Wax, Fine. — Melt cautiously 4 oz. pale shellac in a copper vessel, at the lowest possible temperature; add 1¼ oz. of Venice turpentine, previously warmed, and stir in 3 oz. vermilion; pour into metallic molds and allow it to cool.

Red Sealing Wax, Common. — Resin, 4 lbs.; shellac, 2 lbs.; melt; mix in 1½ lbs. Venice turpentine and red lead.

Black Sealing Wax, Fine. Shellac, 60 parts: Venice turpentine, 20 parts; melt shellac carefully; add Venice turpentine; stir in 30 parts of finely-powdered ivory black.

Black Sealing Wax, Common. — Resin, 6 lbs.; shellac, 2 lbs.; melt. Add 2 lbs. Venice turpentine, and lamp black to color.

Gold Sealing Wax. — Melt cautiously 4 oz. pale shellac in a copper vessel, at the lowest possible temperature; add 1¼ oz. of Venice turpentine, previously warmed; and stir in 3 oz. mica spangles; pour into metallic molds, and allow it to cool.

Colored Sealing Wax. — 4 oz. pale shellac, 1¼ oz. white resin, 2 oz. Venice turpentine; add a finely powdered pigment of the required color.

Bottle Wax. — (1.) Resin, 6½ parts; beeswax, ½ part; Venetian red or red lead, 1½ lbs. (2.) Shellac, 3 parts; Venice turpentine, 1¼ parts; vermilion, 2¾ parts, or Venetian or red lead, q. s. (3.) Resin, 6 parts; shellac and Venice turpentine, each, 2 parts; coloring matter to suit.

Wax, Graft'ing. This is an article which should be kept on hand ready for use whenever needed, for it is valuable for various other purposes besides that of grafting. All wounds made in pruning trees will heal over much sooner if coated with this wax; and, if a piece of bark is accidentally stripped from a tree, the place should be covered over with it, and the wood will remain sound underneath. A good wax may be made as follows:

Melt in a basin 1 lb. of tallow, 2 lbs. of beeswax, and 4 lbs. of resin; stir well together, and keep in a cool place in the dish in which it is melted. If beeswax is a very costly item, one-third less quantity can be used.

Wax'-thread Sew'ing Ma-chine'. A sewing machine for sewing leather with waxed thread. Such machines are made to work with two threads or with one.

In the single thread machine the needle carries down the thread, which is caught by a looper working in the pillar beneath, and thereby held till the leather is fed forward so that the next descent of the needle will be through the former loop. Provision is made for keeping the waxed thread warm so that it may be flexible. The warming is usually by a lamp which heats a current of air in the duct through which the thread passes. In other cases the thread passage is heated by hot water. The wax is heated by a lamp beneath and the thread is conducted from the spool, through the wax and along a heated passage to the needle.

Way. (*Railway.*) With one exception, the Paris Exposition did not furnish any valuable suggestions of new uses for iron. This exception relates to the introduction of various systems of iron permanent way for railroads, in place of the wooden cross-ties and stringers which are now generally in use.

One of these systems, Hilf's, has been adopted on nearly 1,000 miles of railway in Germany, Austria, Belgium, and other countries. Both the stringers and the cross-ties are of wrought-iron. Other systems, at least one of which substitutes steel for iron, are modifications of the Hilf system. It seems not improbable that one or two of these systems will become popular and even necessary in countries which do not possess an abundance of timber, but at present many objections are made to their adoption. It is alleged that the first cost of an iron permanent way, cheap as iron has become, is much greater than one of wood, and that it is liable to corrode, and is more rigid than wood.

Iron, however, has found new friends in those inventors who have suggested its use in the construction of the so-called permanent way of railroads, and various systems of this new permanent way are now in daily use on the Continent. In Great Britain one or two of them have been used experimentally, and a commencement has been made in shipping iron for the construction of the permanent way of an Indian railroad.

Wear I'ron. The projecting piece of iron fastened to the bottom of a buggy or wagon to protect the wheel from wearing away the body in turning.

Weath'er-board'ing Saw. A combination saw, composed of saw, square, level, plumb, and rule, allowing the carpenter to plumb, space, true, saw, and fit on weather-boarding without other tools.

Weav'ing. The manufacture of fine blankets by the Navajo women is thus described: —

The wool is all spun with the fingers and without the aid of a wheel, the process being very slow and requiring great skill. The colors are all vegetable. As two women spin the warp two others stretch the yarn upon pegs driven into the ground, each thread being as long as the blanket is to be. When the warp is made and arranged, the woof or filling is spun in the same way, and each thread woven in by hand and with the greatest care. In this manner four women make four fine blankets in about three months. The Navajos have not lost the art of weaving blankets. While the men hunt and herd cattle and sheep, the women spin and weave blankets for their own use and for sale. Some are coarse and can be purchased for from $3 to $6, but others are so fine and tightly woven that they will hold water like a rubber poncho, and sell for from $25 to $75 each.

Diagrams showing the principles of various *armures* or dispositions of the harness for twills, satins, etc., may be found in *Laboulaye's "Dictionnaire des Arts et Manufactures,"* article *"Tissage,"* vol. iii., ed. 1877.

We'ber. (*Electricity.*) The practical unit of quantity (1 weber — $\frac{1}{10}$ (C. G. S.)). —*Ampère.*

The practical unit of resistance is called the ohm or B. A. unit (1 ohm — one billion absolute electromagnetic units). (1 ohm — 10^9 (C. G. S.).) — *Gordon.*

We'ber-me'ter. Edison has lately patented a "webermeter." This is an instrument for measuring the amount of electric current flowing through a circuit, or in other words a meter for electric currents to tell the number of webers that have been supplied.

Wedge. (*Nautical.*) One of the supporting blocks of a ship on the ways.

Wedge Cut'ter. A dentist's cutting pliers to excise the ends of separating wedges, inside and outside of the jaw.

(*Carpentry.*) A combined relisher and wedge cutter for relishing the rail of a door and cutting the wedges at one operation. The first arbor is perpendicular, the second upright arbor is thrown forward on the right angle to give the bevel to the wedge, and can be adjusted to give different bevels to accommodate different widths of tenons, or can be moved to a perpendicular. The two horizontal arbors are adjusted by screws, and can be moved up and down to cut any width of relish. The two small saws are fastened on end of arbors with screws, the heads being flush with face of saws. The sliding bed moves the length of machine on tracks. The rail to be relished is placed on its worked edge, on the bed, with shoulder against the stop (which can be adjusted to any depth of cut), and run through machine, thus cutting the relish and wedge in one movement. One man can relish the rails and make the wedges for 1,000 to 1,200 doors in ten hours.

Wedge Valve. A wedge-shaped valve driven to its seat by a screw. Used in closing mains, etc.

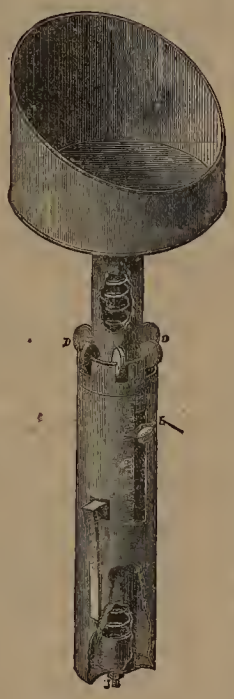
Weed'ing Hoe. One style is made with three small triangular blades or shares which cut the

weeds off at the surface of the ground, or lower, and are adjustable laterally to cut all in one broad row, or spaced apart as desired.

Weed Scythe. See BRAMBLE SCYTHE.

Weigh Can. A can containing a liquid, resting on scales. The indicator is fixed at the present weight less the amount wanted; the faucet is opened, and when the beam rises the flow is cut off.

Fig. 2530.



Weighing Scoop.

Weigh'ing Ma-chine'. Figs. 1423–1425, p. 486, *supra*, show a convenient form of hydrostatic scale for weighing in transitu.

See also STEELYARD, TRACK SCALE, PLATFORM SCALE, SUSPENDED SCALE, etc.

Weigh'ing Scoop. Mery's scoop has a spring balance located in the scoop handle, scale and pointers on the handle, and a stop so arranged as to save the spiral balance spring from damage when the scoop is thrust into any hard, unyielding material.

When the scoop is in use the handle is naturally grasped so that the thumb is directly over the stop *L*, and a slight pressure on it when the scoop is thrust into any material prevents the stem from being pushed down upon the spring, and causing any damage to it. The combination of handle and stem is made stiff and unyielding by reason of the stop, thus facilitating the scooping up of any hard unyielding material.

When the material to be weighed is raised up in the scoop, the stop is released and the balance, being free to act, the weight of the material will show on the scale. This arrangement of scoop and scale gives two useful articles in one, and is very serviceable where a large amount of material has to be divided by weight into small quantities.

Weight'ed Car'riage Lathe. One in which the carriage rest is held down by a weight.

Weight'ed Gage Cock. One in which the piston or valve is held to its seat by a weight. See Fig. 2531.

Fig. 2531.

Weighted Gage Cock.

Weight'ing. Loading silks, cotton, and other goods with foreign substances in dyeing, to give them body and weight. This fraudulent practice is resorted to in many cases, the principal weighting material used being chloride of magnesium. Sulphate of magnesium (Epsom salts), oxymuriate of tin, sumac, galls, gums, sugars, salts of lead, oxides of iron, and other articles of a similar kind are used by unscrupulous dyers to give to silk an artificial weight, regardless of the fact that the goods are seriously damaged thereby, for use.

Weir. A dam across a stream to raise the water to a higher level, either for milling, fishing, or navigating purposes.

The rivers Seine and Yonne have been made navigable for small vessels, between Paris and Auxerre, by a system of weirs which give a minimum depth of about 5′.

This has been accomplished by building 34 movable dams, with side locks, and also making three cut-offs; every cut-off has a guard-gate at its head to keep out the flood water, and a movable dam, without a lock, is built across the river just below each gate. See BARRAGE, p. 76, supra, and Plate IV.

The above operations have served to convert the two rivers into a series of navigable pools. Rivers so converted are said to be canalized.

Each weir, 150′ wide, is composed of a fixed and movable portion, the fixed part consisting of a mass of béton, faced with masonry, poured between two lines of sheet piles with an interval of 25′ between the lines. This mass rises to within 3½′ of the upper bay level. This fixed part is surmounted by 33 movable gates 5′ wide, with their tops, when they are up, at 3½′ above the permanent portion. These gates were designed by M. Desfontaine, and called by him *hausses à tambour*, or drum gates.

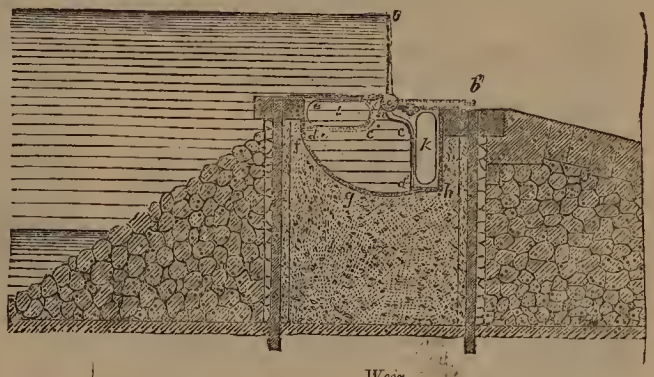
The object was to operate the dam by utilizing the power produced by the fall itself.

The moving apparatus, Fig. 2532, consists of a series of gates, independent of each other, and turning around a horizontal hinge, *a*, placed in the middle. The upper half, *a b*, is the *hausse* or gate, properly so-called; it is this which forms the upper bay. The lower half *a c d*, called the counter *hausse*, has no other function than to carry along the *hausse* in the movement impressed upon itself. It is inclosed in a quarter of a horizontal masonry cylinder of the same length, whose axis coincides with the hinge, and in which it can consequently make a quarter of a revolution. The horizontal one is slightly raised parallel to itself, and the vertical one has been similarly moved back, so as to leave the empty spaces *l* and *k* between the drum and the extreme positions of the counter *hausse*.

By admitting water from the upper bay into the chamber *l*, when the bay is full, the gates are revolved on their axes, and the bay emptied as far as desired. The admission of the water into *k* raises the gate again.

The simplest form of a *fish weir* consists of a fence of brush

Fig. 2532.



Weir.

driven into the sand or mud and forming a curve concave to the ebb of the tide. As the water runs off, becoming more shallow, the fish in the inclosure are detained and are captured when stranded.

A *dry* weir is one on a flat left dry by the ebb of the tide.

Weirs are called *slat* weirs or *brush* weirs when made of boards or brush respectively.

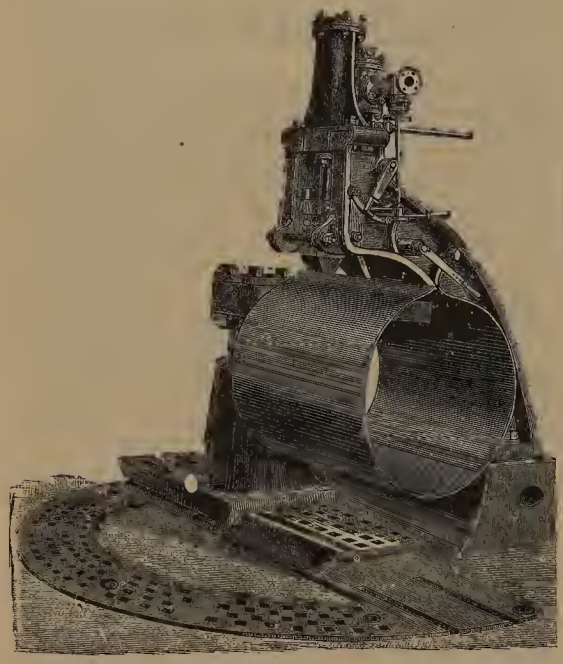
Weirs may have leaders of brush or slats and pounds of net, or the heart and net may be of brush below and netting above.

Weir and *pound* are almost synonymous terms.

Weld'ing. A welding block mounted on the long slide, carries a welding bar, upon which saddles may be fitted for different diameters. The block and bar carrying the flue are traversed along the bottom slide, and as much length as can be heated may be welded at once. See Fig. 2533.

Weld'ing Tubes. Herr Krupp, of Essen, Germany, has recently patented in Germany a method of welding tubes and tires. He draws the tube over one of a pair of ordinary rolls, and then heats

Fig. 2533.



Welding Hammer.

the whole length of the portions to be welded by a special contrivance, which is a portable fire-box, into which air is so blown that the heat is directed against the weld. After the necessary heat is attained the rolls are set in motion and the place to be welded is repeatedly drawn through them. His heating apparatus could, we believe, be replaced to advantage by some gas apparatus similar to that used for heating wagon tires in this country and in France.

Well-bor'ing Tools. The tools used in well-boring may be classed under five heads.

1. Drills, acting by percussion.
2. Augers, for boring by rotation.
3. Reamers, for enlarging the hole.
4. Sand pumps, for extracting detritus or soft material.
5. Grabs, for recovering fallen or broken tools, rods, or tubing, and for raising or lowering rods or tubing.

The simplest plan for operating boring tools is the Chinese; the tools are suspended from a rope which is worked vertically and imparts by its torsion a circular motion to the tool. The well is tubed as the work progresses. This plan, while it has the merit of simplicity, is liable to the objection that the tool is apt to follow fissures, to avoid nodules and hard seams, and thus become deflected from the true course.

The usual mode of boring is to attach the boring tool to the end of a section of rod, which, as the work progresses, is lengthened by the attachment of other rods, which are in lengths of from 10′ to 20′. A vertical reciprocation is given to the drill stock by attachment to a walking beam, by a lever or by other means, and a certain amount of rotation being imparted to the tool at each stroke causes it to fall in a fresh place at each impact.

The tool acting upon the rock, or the scoop upon the sand, gravel, etc., accumulates a quantity of *débris* which requires to be withdrawn from time to time, the rod being lifted and unscrewed, section by section, and the *debris* removed by sand pump if the tool itself has no provision for withdrawing it. The sections are then again attached and the tool lowered to its work.

The loss of time entailed by this plan, in the raising and unscrewing, emptying, reattaching, and letting down has given rise to a number of inventions designed to withdraw the *débris* as it is made. For this purpose was suggested a downcast and upcast current of water circulating through two tubes or on each side of a partition in a single tube. Another device, patented in England in 1844, by Beart, was to make the rods hollow, with water-tight joints, and then introduce a downcast current of water which carried the *débris* up the space between the rod and the wall of the well.

Pumps of various kinds have been contrived, designed to accomplish the same purpose, and other inventors have made hollow drill-rods with a succession of valves, the water and *débris* being supposed to work their way from section to section upwardly by means of the forcible contact of the tool with the yielding strata.

When danger is apprehended from the weight of the drill-rod, a slide-joint may be made which will limit the percussive action to one or two sections at the lower end of the rod while the portion above the joint is counterbalanced so as not to be involved in the blow.

This slide-joint is the invention of Œuyenhausen.

See full-page plate of well-boring tools, p. 2758, "*Mech. Dict.*"

Well Smack. A perforated submerged cage attached to the bottom of fishing smacks for transporting the fish to market alive.

Welt Ma-chine'. A machine to cut leather, cloth, etc., into a series of parallel strips to be used as welts in side seaming. The material is passed into the machine irrespective of its width, the end knife separating the portion not cut into strips before it can be carried against the standard.

Well'-wheel Block. A grooved pulley for the cord of the well-bucket to run over. It has a hook for suspension and anti-friction rollers for the axis.

Wet and Dry Plates. The wet plates used in photography and prepared by the photographer at time of taking a picture, are being largely superseded by the dry or gelatine plate, which can be prepared or bought in advance, and carried around for taking views, or other pictures. These dry plates are practically instantaneous. See work by J. Traill Taylor, published by the Scovill Manufacturing Co., New York.

Wet Broke. (*Paper.*) The moist and imperfectly felted stock or pulp as it leaves the wire cylinder and before being smoothed out on the forwarding blanket.

Wha'ling Ap'pa-ra'tus. For list of U. S. patents on whaling apparatus, harpoons, bomb-lances, rockets, and explosives used in fishing and whaling, 1838–1879, see HARPOON.

Wha'ling Gun. Off the Norway coast, near Wadso, whales are killed by the use of a gun invented for the purpose.

The gun has a chamber about four feet long, is mounted on the forecastle of the vessel, and, being balanced, can be easily moved to allow aim to be taken. The projectile in use consists of a long iron bolt, having at its extreme end four harpoons bound round with a line so as to be flat, and close to the harpoons a five or six pounder shell. As soon as the steamer has approached sufficiently near to the fish, the bolt is fired off, and, if well directed, penetrates deeply into the flesh and blubber of the animal. The whale rushes off at a furious pace, and the effect of his rapid movement is to make the bolt slip back a little, thus setting free the four harpoons from the lines, and, by means of a mechanical arrangement, causing the shell to explode. This generally proves the *coup de grace*.

A fire arm or small cannon hurling a bomb, harpoon, or lance. Patents: —

Brand	June 22, 1859.
Pierce	1865.

See also HARPOON GUN.

Wha'ling Rock'et. A projectile carrying harpoon, line, and explosive, used in whaling.

The Roys rocket has a strong brass cylinder containing the projectile charge. In the front of this is secured a bomb containing an explosive charge, and inside of it is a harpoon attached to the shell. To the rear end of the rocket, is attached the whale line. The bomb has a bearded or barbed point, and when projected into the whale by the rocket explodes, inflicting a fatal wound, the harpoon takes its hold, and the boat is fastened to the whale by the line. These shots are good for killing and fastening to a whale at 30 fathoms distance. The whole apparatus weighs 32 pounds, and is 6′ 6″ in length.

A peculiar rest is used in firing, having on it a shield to protect the operator from the fire which issues from the rear end of the rocket. The rocket is set in the rest, the rear end of which is placed on the shoulder, and by discharging a pistol charge into a hole provided for the purpose, the projectile is discharged and the rocket powder carries the rocket, bomb, and line in the direction required.

Whale'men's Tools, Knives, etc. *Blubber Fork.* Used for tossing blubber into the try kettle.

Blubber Hook. Used in hauling small pieces of blubber on deck.

Blubber Knife. For cutting up blubber for trying out.

Boarding Knife. For cutting the blanket-piece of blubber or long piece which is flensed or peeled from the sides of the whale.

Boat Spade. Used from the boat to disable the whale by cutting its flukes.

Boat Hatchet. Same use as *boat knife.*

Boat Knife. To cut the harpoon line when it becomes tangled in paying out. Kept in its sheath on the bulkhead of the whale-boat, ready for use.

Cutting Spade. Used in peeling the blubber from the carcass of the dead whale. Known as "cutting in the blubber."

Half-round Spade. For cutting the "blanket" piece, to allow blubber hook to enter.

Head Knife. For cutting off the head of the whale; opening the skull to obtain the spermaceti; removing the baleen, etc.

Head Spade. For cutting off the head of the whale.

Junk Hook. Used for hauling heavy pieces of blubber on deck.

Lance. To give the whale its death thrust.

Line Hook. A hook for catching the line.

Lip Hook. A grapnel for catching in the whale's lip, to tow it to the vessel.

Mincing Knife. For cutting the blubber into small pieces.

Mincing Spade. For cutting the blubber into small pieces before trying out.

Throat Spade. Flat with a round shank. Used in cutting off the head of the whale.

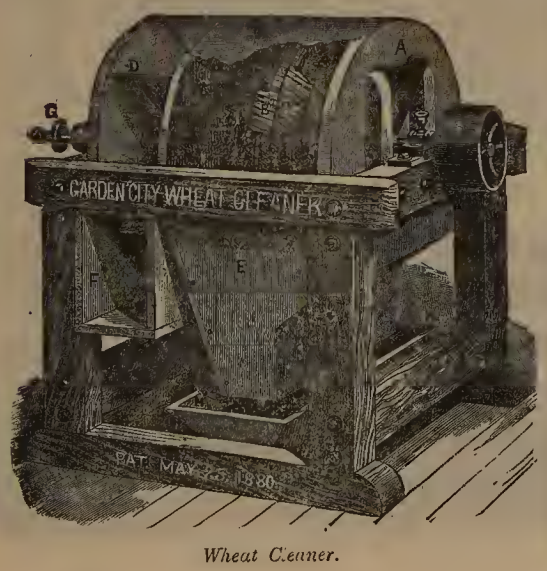
Whaling Gun. A fire arm or small cannon hurling a bomb, harpoon, or lance.

Wide Spade. Used in the blubber room for cutting blubber in the rough, before mincing.

Wheat Brush. A device for scouring grain.

The illustration, Fig. 2534, shows two bristle brushes, with the bristles inclined. One of the brushes revolves while the other is stationary. The wheat enters the hopper *A* and passes to the center between brushes B^1 and B^2, whence it is carried by centrifugal force to the periphery of the brushes, when it falls into the air-chamber *E*, whence the dust is removed by the suction created by fan *D*.

Fig. 2534.



Wheat Cleaner.

Wheat Crack'er. (*Milling.*) A mill for making grits. See GRITS MILL.

Wheat Damp'en-ing and Dry'ing Machine'. Apparatus for washing and cleansing smut and dirt from grain, and drying the wheat when washed. See GRAIN WASHER.

Wheat Drill. See GRAIN DRILL.

Wheat Gra'der. A machine for separating the perfect from the imperfect grains, and for sorting out long from round grains, or removing dirt, stones, etc., from grain. See GRAIN SEPARATOR, STONE CLEANER, WHEAT SEPARATOR.

Wheat Heat'er. (*Milling.*) An apparatus for heating grain before grinding in order to facilitate the loosening of the bran coat. It is usually some form of steam heated chamber, and in Welch's wheat heater, it has a perforated steam ring for damping the grain also, if desired.

It has an interior iron cone, heated by one steam-pipe, and a frusto-conical steam coil a short distance outside of the cone. The live steam pipes of each are above and the waste below. The wheat enters the machine and passes down the channel between the conical coil of pipe and the central iron cone, which is notched on the outside, spreading out and passing through a series of openings in the bottom, where it is collected by the hopper at the bottom of the machine, and spouted to the burrs. The ring just below the wheat induction opening is for steaming the grain, when required; the pipe having its own valve. The space outside the steam is packed with asbestos to prevent radiation of heat. The length of the apparatus is 26.5″. Capacity, 15 bushels per hour.

Several forms of apparatus may be found under the following references: —

Provost, "Victor" . .	* "*American Miller*," vi. 148.
Gratiot	* "*American Miller*," v. 83.
Price "IXL."	* "*American Miller*," v. 83.
Fulton	* "*American Miller*," vi. 277.
Osborne	* "*American Miller*," vi. 148.
Deal	* "*American Miller*," viii. 237.
Welch	* "*American Miller*," viii. 287.
Palmer	* "*American Miller*," viii. 461.
Hunt	* "*Leffel's Milling & Mech. News*," vii. 4.
(Steamer)	"*Leffel's Milling & Mech. News*," ix. 89.
	"*Scientific American*," xlii. 152.

Wheat Mag'nets. Fig. 2535 shows forms of magnets for inserting in the mill spouts to gather the pieces of wire that may have gotten in from the use of wire binders or other sources.

Fig. 2535.

Wheat Magnets.

Wheat Rid'dle. See SEPARATORS, full page of plates, p. 417, *supra.*

Wheat Scour'er. (*Milling.*) A machine which follows the smutter.

It consists of a stiff brush, against which and below, a grooved burr-stone is made to revolve, the wheat passing between the brush and burr-stone. It serves to remove still adhering hairs and loosened portions of the outer bran, and presents, after passing through a blower, a berry of remarkable smoothness and look of purity. By this process, some varieties of wheat lose, beside the hair, portions of the outer layer of true bran, traces of the cigar-coat, and scales from the surface of the embryo.

To effect the same end in other mills, the wheat is passed between a grooved steel cylinder and a segment of a stone shell in which the abrasion of the surface of the wheat and the partial removal of the outer bran coat are effected.

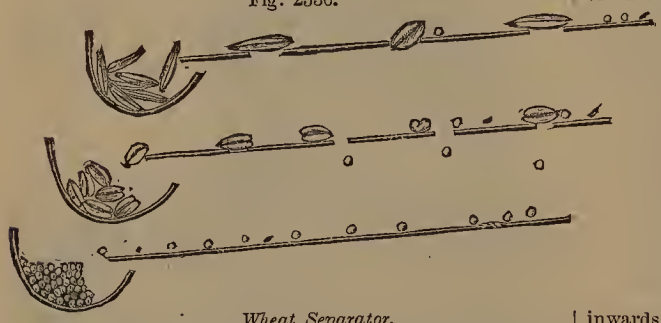
Another form has a cylindrical grater operating against a

surface of stone. The wheat enters the machine at a spout and comes in contact with a system of cast-iron spiders. Passing through in a spiral form, it is discharged. The screenings are delivered from one spout and the dust from another. The separation can be adjusted by a movable valve.

Wheat Sep'a-ra-tor. The separation of mustard, cockle, and grass seed from the wheat is effected by passing the mixed grains over inclined plates perforated with holes large enough for the smaller seeds to pass through but not large enough for the wheat.

The oat-grain is separated by taking advantage of its elon-

Fig. 2536.



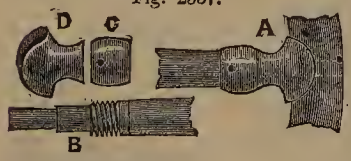
Wheat Separator.

gated form. The mixed oat and wheat grains are discharged in a thin sheet upon an inclined, jogging, thin, iron plate, perforated with round holes, at intervals nicely determined by experiment, abundantly large for the ready passage of both the wheat and oat grains if presented end foremost perpendicularly to the surface of the plate. But as the plate is inclined, each berry must be tipped forward in order to enter a hole. An individual hole is of such diameter that when the wheat-grain sliding forward carries its center of gravity beyond the support of the upper edge of the hole, there will be room for the prow, that is, the forward end of the grain, to sweep downward through the hole without striking its lower margin, and thus the wheat-grain be separated. The oat-grain, however, in sliding down the inclined plane, before the center of gravity has passed beyond the support of the upper margin of the hole, will, by reason of its prolonged hull, extend over the lower margin of the hole, and thus fail to fall through. As the oat-grain advances, the center of gravity will pass beyond the lower edge of the hole and gain the support of the continuous surface before the tail of the berry will have lost the support of the upper edge.

Wheel. (*Vehicle.*) A circular frame supported on an axis, distinguished from a roller by the axle bearing the stress.

Fig. 2537 shows the Raddin elastic adjustable iron and wooden spoke for carriage wheels.

Fig. 2537.



Adjustable Spoke.

The cut shows the manner the felloe is expanded to set the tire. *A* represents a spoke and felloe, with clasp and nut ready to be expanded to set the tire. *B* shows a spoke with screw-thimble to receive the nut *C* and hasp *D*. By turning the nut on each spoke the felloe is expanded, the tire is set, and the wheel made round, which cannot be done by the ordinary method.

Smith's wheel has a metallic hub with the spokes clamped between collars. The outer collar is held on by a jam nut and a loose spoke can be replaced without removing the tire.

The spokes in the Watson wheel pass through a metallic collar encircling the hub, the two parts of which are joined by connecting pieces which form wedges to spread and tighten the spokes as they are driven in.

Wheel Cut'ting Ma-chine'. A device for dividing a circle into any number of equal divisions.

Wheel cutting machine.
Scott . . . . . * "*Engineering*," xxiii. 381.
Wheel cutter bevel.
Grube . . . . . * "*Scientific American Sup.*," 450.

Wheel En-gra'ving. (*Glass.*) As distinguished from sand-blast engraving or acid etching. See GLASS ENGRAVING.

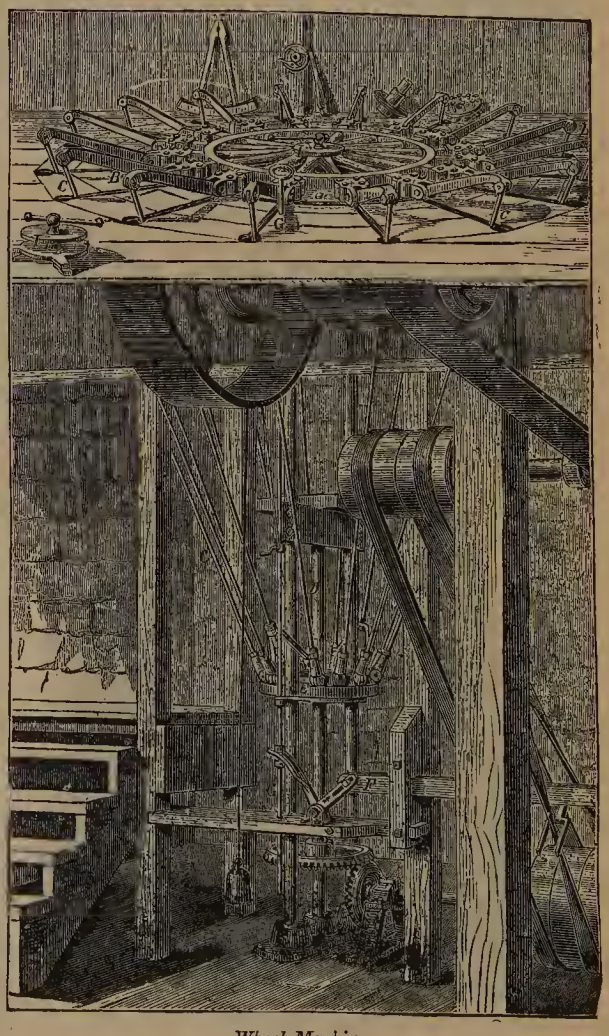
Wheel Hoe. One, or a series of hoes, mounted on a wheeled frame, and adapted to be pushed by hand. Revolving disks are sometimes interposed between the plants and the hoes to prevent the plants being smothered with earth.

Wheel Joint'er. For trimming the joints of staves, heading, etc. See HEAD JOINTER, *supra.*

Wheel-ma'king Ma-chin'e-ry. Apparatus for pressing hub, spokes, and felloes into a solid wheel at one operation.

Fig. 2538 shows Archibald's wheel machine, which occupies space upon two consecutive floors. A strong circular plate of cast-iron, about 7′ diameter, having its upper surface faced off true, is placed horizontally level with the second floor. Arranged at equal distances around its outer edge are a number of levers, *B*, equal to the number of spokes to be set in the wheel, having their fulcrums securely bolted to the plate. The long arms of the levers radiate from the plate, about 3′ all around, the short arms are formed into cams, or rolling inclines, or curved wedges, acting upon sliding pieces of cast-iron, which move freely in a radial direction, in guides formed in the fulcrum blocks. When the long arms of the levers are raised, the sliding pieces are pressed outwards by springs until they bear upon the cam-shaped short arms of the levers at the point nearest the fulcrum or center of motion of the lever. When the long arms of the levers are lowered, their sliding pieces are forced inwards by the cams, and unite in pressing inward the wheel. The levers are actuated by means of wrought-iron rods, *C*, extending downwards from the ends of the levers, converging to a vertical column, *D*, under the center of the plate, much as the braces of an umbrella extend downwards from the ribs to the stick. A screw is cut upon the central column, and a nut, *E*, answering to the slide upon an um-

Fig. 2538.



Wheel Machine.

brella stick, raises or lowers all the levers at once, with great facility, and with any required power. Motion is given to the nut by means of beveled gears, and a belt with fast and loose pulleys, so arranged that at the upward and downward limits the belt is thrown automatically upon the loose pulley, and the motion of the nut and levers stopped. Any required motion, either up or down, within the range of the screw, can be obtained with great delicacy and convenience by a shipper, *F*, actuated by a shipping-rod, *G*.

Wheel Plow. One having a wheel in adjustable standards depending from the front end of the plow-beam to regulate the depth of the furrow.

Wheel plows.
Ransome, Br. . . . . * "*Engineering*," xxvii. 436.
Wheel plow, *Howard*, Br. . . * "*Engineering*," xxx. 49.

Wheel Press. A hydraulic press for forcing car-wheels upon their axles.

Wheel Ribs. Projections on the inner side of plate car-wheels to strengthen them.

Wheeled Scra'per. One mounted on trucks to scrape and level newly-dumped dirt on railroad tracks.

Wheel Seat. The part of an axle inclosed by the hub of a wheel.

Wheel'wright Ma-chine'. A machine for doing the different varieties of work necessary in the forming of a wagon wheel.

Some forms will plane wagon or buggy rims when on the wheel, and plane the periphery of a rim made of sections (*i. e.*, sawed felloes), so that each section shall have a true circle of its own, greater than the circle of the wheel, forming what is known in the trade as swelled joints, without which such wheel would be deficient, as the rim is always inclined to dent in at the joints of the felloes. The amount of irregularity can be varied, and is quickly changed so as to plane a bent rim to a true circle.

The rim planer will also plane stuff straight, out of wind, square, and to thickness (and 8″ wide with an extra cutter-head of this width). The upper table may be taken off its hinges without removing a bolt, and a saw board substituted, making an adjustable saw table for rip-sawing or cutting-off, the cutter-head being exchanged for a saw.

The machine thus fitted, and furnished with back-top, adjustable fence and bevel rest, patent gaining and saw frame, is a complete universal wood-worker, without interfering with the rim planer.

On the opposite side, when desired, is attached a spoke saw and wheel tenoner, with or without a boring table. It can be changed to a boring machine without the use of a wrench.

Two men may operate on the machine at the same time, one on the front side and the other on the opposite side.

A horizontal shaper may be made of the rim planer, which will shape, round, and corner all ordinary work.

Whelps. 1. (*Nautical.*) The projecting ribs of a capstan, around which the rope is wound, generally of the form of a frustum, to keep the rope from becoming jammed against the pawl.

2. The teeth or projections of a sprocket wheel.

Whet'stone. A report on this subject by *J. M. Safford* is given in that of Group I., "*Centennial Exhibition Reports*," vol. iii., p. 172, *et seq.*

Whin. (*Mining.*) A machine for raising ores and refuse.

Whip Crane. That form of crane in which the winding rope passes over the periphery of a larger wheel, on whose barrel axis the lifting rope coils itself. Such cranes are independent on rooted posts or are supported above according to the exigencies or facilities of the case; the latter swings completely round, is fitted with three purchases or speeds of lifting, and with break apparatus for lowering. Weights up to 600 lbs. are lifted quickly by pulling directly upon the rope; for weights up to one ton the handle is put on the rope-barrel shaft; for heavier loads the handle is put on the pinion shaft.

The upright and jib are of pitch pine timber, with cast-iron shoes, top and bottom, wrought-iron pivots, and square cast-iron plates for fixing to floor and beam. The jib is fitted with cast-iron bracket and jib-head and wrought-iron tie-rods to the top pivot casting.

Whip Gin. A simple tackle-block, over which a hoisting-rope runs. Also called *gin block* and *monkey wheel.*

Whip on Run'ner. (*Nautical.*) A tackle with two single blocks, one a standing and the other a running block. The fall of the standing-block is spliced round the block of the lower whip. A *whip-on-whip*. *b* Fig. 6159, p. 2480, "*Mech. Dict.*"

Whip'ping. (*Nautical.*) Tying or binding with twine the end of a rope to prevent its untwisting. For list of *whipping, lashing, seizing*, etc., see SEIZING.

A Spanish whipping occupies an intermediate position between a knot and a splice, and gives a very neat finish to a rope's end. Unlay the rope for 12″ or 15″ and make a crown with three strands. Then carry the strands severally through the body of the rope, downward, as in a short splice, gradually tapering the strands away. In making a Spanish whipping, as in splicing of all sorts, — the long splice excepted, — a marlinespike must be used to open the body of the rope to receive the ends of the strands.

Whip Ma'king. For method of covering whips, see BRAIDING MACHINE, p. 355, "*Mech. Dict.*," and for history, etc., see WHIP, p. 2769, *Ibid.*

The main items of expense in whip making material are rattan and whalebone. The rattan is imported from Batavia and China. The qualities which are too soft, or otherwise unfit for use in whips, are sorted out and sold to the basket-makers. The fine strips which make up the stock of a whip are split out first by hand, and afterwards worked down by drawing them through a shave, which can be gaged. The whalebone is already split when imported.

The main part of most whips is composed of nine pieces. The whalebone is in the center, surrounded by the thin strips of rattan, and secured in place by glue. This compound stock is dipped in glue so that every part is permeated by it, and then run through a machine, which winds it with a strong thread from end to end. It is again wound with rope, so that it cannot warp out of shape, and left to dry. A peculiar turning lathe gives a smooth finish and even taper from butt to tip.

The thread covers are plaited on to the stocks by machines, which are wonders of ingenuity; some carrying as many as 24 spools. Some of the better grades of whips have this cover made of fine gut, prepared from sheep entrails. Sometimes a portion is worked on by hand, and fancy designs in colors, or the owner's name is introduced. A great variety of sticks is used for the stiff portion of the stock, many of them being very handsome, and include the holly and other ornamental woods. The Malacca cane, which grows in the Dutch East Indies, and is imported, is also used largely.

Fine lashes for stage drivers, teamsters, or tandem whips are plaited out of the best Californiа deer skin. They contain from 4 to 24 strands, and are from 4′ to 16′ long. Horsehide answers for the cheaper grades used by cartmen and others.

Plaiting lashes well can be done only by careful and experienced hands and is all piece-work. Much of it is given out to be done at the homes of the operatives.

Whis'ker Gaff. (*Nautical.*) One of the spars rigged out from the bow to spread the guys of the jib-boom. Also called a *sprit-sail gaff.*

White Brick. A process for the manufacture of white pressed brick from common red clays, consists in mixing or grinding into the common clay a cheap material, chiefly magnesian limestone, which has been reduced to an impalpable and harmless powder by being burned and slaked.

This compound is passed through a series of mixing and grinding mills, and so completely ground that it leaves the last mill reduced to a fine powder; in this state it falls through the feeder into the molds of a powerful steam-pressing machine, is subjected to a heavy pressure, and is delivered at the delivery table a complete and almost dry pressed brick, which, when burnt in the kiln, produces a white brick of good quality. The ingredients added to the clay at once absorb about 40 per cent. of the moisture found in the natural clay, and the grinding is so close and complete that the mixture is thoroughly and evenly amalgamated. The change effected in the color of the red clay on being burnt is due to the presence of the mixture.

White Bronze. A name given to either of several light-colored bronzes. See NICKEL BRONZE; MANGANESE BRONZE. See list under BRONZE.

White Cloud Il-lu'min-a-tor. A round piece of plaster of Paris fitted on the microscope, reflecting a white beam of light, often used instead of the ordinary mirror.

White Glass. (*Glass.*) A term used in England to distinguish certain brilliant uncolored glass from *flint* glass, which has lead in its composition. See FLINT GLASS, CRYSTAL.

Whi'ten-ing. (*Leather.*) The leather is laid over the beam, and with an extremely fine-edged knife a thin shaving is taken from the flesh side.

Whi'ten-ing Ma-chine'. A buffing machine, operated by power, to buff, whiten, or flesh leather in finishing.

Whit'worth Steel.

One of the most interesting of the British steel exhibits at the Paris Exhibition, 1878, was that which embraced various samples of the "Whitworth metal," to which much importance has been attached in Great Britain in connection with the manufacture of ordnance and other articles by the Siemens and Siemens-Martin processes. The exhibit was large, and of a character to favorably impress the visitor. The metal is made of more than ordinary solidity and tenacity by being cast under hydraulic pressure. Cannon and shells of this metal are said to withstand the severest tests, a claim that received confirmation from some of the samples submitted. A propeller shaft was exhibited, forged hollow, which it was claimed was much stronger than a solid wrought-iron shaft of the same size and weighing one-half more. This shaft, forged from a hoop of compressed steel, was 33′ 7″ long, the outside diameter 17½″, and the diameter of the bore 11⅜″. A hydraulic cylinder of this metal was shown which was represented to stand a pressure of four tons to the square inch. For machine tools, in which strength combined with lightness is desirable, the compressed steel is claimed to have no equal. Sir Joseph Whitworth's aim has been to produce a steel that would be free from blow-holes, and this result he has accomplished by mechanical means. A similar result has been claimed by the Terre Noire Company, in France, through chemical combinat ons.

White'wash. A good durable whitewash is made as follows: —

Take half a bushel of freshly burnt lime, slake it with boiling water; cover it during the process to keep in the steam. Strain the liquid through a fine sieve, and add to it 7 lbs. of salt previously well dissolved in warm water; 3 lbs. of ground rice boiled to a thin paste and stirred in boiling hot; ½ lb. of powdered Spanish whiting; 1 lb. of clean glue, which has been previously dissolved by soaking it well, and then hanging it over a slow fire in a small kettle, within a large one filled with water. Add 5 gallons of hot water to the mixture, stir it well, and let it stand a few days covered from dirt. It must be put on quite hot. For this purpose it can be kept in a kettle on a portable furnace. About a pint of this mixture will cover a square yard.

A recipe almost identical is recommended by the Treasury Department to all lighthouse keepers. It answers for wood, brick, or stone.

Wide Spade. (*Whaling.*) Used to cut the blubber in the rough, before mincing.

Wil'low Cur'tain. (*Hydraulic Engineering.*) A device to curb the rapidity of streams and induce deposit of sediment. Its action is similar to the FLOATING BRUSH DIKE, which see. See also FLOATING WIRE DIKE.

The willow curtain is made of willows 1″ to 2″ diameter, and fastened parallel to each other and 6″ to 8″ apart, by means of wire. It is made of any desired width and length and anchored in position in the stream by weights attached at intervals along the lower edge, and sustained by buoys made fast to the upper edge. — "*Report of U. S. Engineers*," 1880, pp. 1452, 1459.

The tools and methods are well shown in the "*Chief of Engineer's Report*," 1879, *ii. 1074, *et seq.*, Plate IV.

Winch. A hoisting machine operated by hand, crank with gearing, and tackle, which should always have a follower or dog, as a safety-brake.

Wind Fur'nace. (*Metallurgy.*) One depending upon the draft of a chimney, as distinguished from a blast furnace.

Wind Gage. A gage attached to a gun to indicate the strength of the wind and enable the person using the gun to make allowance for the deflection of the ball in its flight to the target.

Wind'lass. A drum revolving on a horizontal axis for raising heavy bodies. A capstan has a vertical axis.

Win'dow Bar. A bar intended as a security against children falling through an open window or door. It is so constructed by reversible screws at each end that it can be extended or contracted to fit the doorway or window.

Window Glass. Common window glass is made by the blowing and whirling process. Plate glass is run into molds, ground, and polished.

The irregular thickness of the Pompeiian window glass shows that it could not have been blown, and M. Bontemps is of the opinion that it was cast in bronze frames.

The analysis shows the following composition: —

Silica	69.43
Lime	7.24
Soda	17.31
Alumina	5.55
Oxide of iron	1.15
Oxide of manganese	0.39
Oxide of copper	trace

Window glass in wooden frames in France under Louis XIV.

Window glass in use in England, XIIth century.

Window glass in royal palace in Edinburgh, 1661.

Painting on glass in Abbey St. Denis, XIIth century (Le Vieil).

Painting on glass in Abbey Leroux, Anjou, 1121.

Painting on glass in Abbey Tergernsere, Bavaria, Xth Century.

See CROWN GLASS, CYLINDER GLASS.

Win'dow Mir'ror. A mirror mounted outside the window, and capable of being adapted at any angle to reflect the passing objects in the street, to the view of persons inside the house.

Win'dow Op'en-er. A lever or rod by which a window, ventilator, sash, or panel in a clear-story is held in any desired position.

Win'dow Sec'tor. A bar or plate of metal of the form of part of a circle, and which is used as a guide or stop to control the movement of a clear-story window.

Win'dow Tube. A glass or hard rubber tube forming a passage-way for an electric wire into a building.

Wine Heat'er. A machine to preserve wine after it has acquired its best condition from its natural fermentation, against secondary fermentation, and all diseases which arise from the development within the wine of animo-vegetal parasites, such as bacteria, vibria, mycoderm accti, etc. It is simply the mechanical application of the well-known and well-established theory of M. Pasteur, the eminent French chemist, that subjection of any fermented liquor to an instantaneous heat of 45° to 55° centigrade (112° to 131° Fahr.), or to a slowly acquired temperature of 65° to 75° centigrade (149°

to 167° Fahr.) will destroy or render inert all germs of fermentation or of animo-vegetal life existing therein.

Wine Press. In the common form used in France the main characteristics are the exact arrangement of the gearing on the nut. The inventions of Mabille frères, Marmonier, Primal, and others differ.

The crate is made of a cylindrical series of slats, hooped and latched. Rising from the bed of the machine is the screw, upon which is the follower, which is forced down by the nut. The latter is rotated by the lever, the laborer at the first merely walking round the press. When he can no longer operate thus, he commences a reciprocating movement, drawing the lever back and forth, which he is enabled to do by a species of gravitating ratchet movement in the apparatus upon the nut.

The cotter-keys are gravitating; each motion of the lever turns the mortise-wheel in a constant direction, the action of the cotters being alternate. While one cotter is effective the other slips up out of its seat, slides over the interveniug space, and drops into the next mortise. The stroke of the lever is 0.8 meter.

Wine makiug, Hammondsport . . . . . * "*Scientific American*," xliii. 79.

Wing. (*Fishing.*) The portion of a hand-seine on each side of that central part which is known as the *bag*.

Wing Net. (*Fishing.*) A net running down stream from one of the stakes of the stake net, to the stake at the mouth of the *hook* net, to guide fish intercepted by the main or *bar* net. See STAKE NET, p. 850, *supra*.

Wing Stop'per. (*Nautical.*) A rope clenched to a ship's beam and at the other end to a cable.

Winze. (*Mining.*) A shaft sunk from one level to another.

Wiped Joint. (*Plumbing.*) One made by placing the parts in the required juxtaposition and covering the joint with a mass of solder.

The wiping action of the woolen pad used originated the name.

Wire. The following table, showing breaking strain of ropes of 133 wires, is from a pamphlet by Messrs. J. A. Roebling's Sons: —

	Diameter. Inches.	Strength. Tons.
No. 1	2¼	74.00
No. 2	2	65.00
No. 3	1¾	54.00
No. 4	1⅝	43.60
No. 5	1½	35.00
No. 6	1⅜	27.20
No. 7	1¼	20.20
No. 8	1	16.00
No. 9	⅞	11.40
No. 10	¾	8.64
No. 10½	⅝	5.13
No. 10½	9-16	4.27

The following shows the weight and resistance per mile of galvanized iron wires: —

Number.	Resistance.	Weight.	Number.	Resistance.	Weight.
6	10 ohms	550 lbs.	11	25 ohms	220 lbs.
7	12.1 ohms	455 lbs.	12	32.7 ohms	168 lbs.
8	14.1 ohms	385 lbs.	14	52.8 ohms	104 lbs.
9	16.4 ohms	330 lbs.	16	91.6 ohms	60 lbs.
10	20 ohms	275 lbs.			

Wire for Brooklyn bridge, bids . . . . . "*Iron Age*," xix., Jan. 25, p. 14.
Wire for East River bridge, making . . . * "*Scientific Amer.*," xxxvi. 127.
Wire manufacture . . * "*Scientific American*," xl. 319.

TABLE OF WIRE RESISTANCE AND WEIGHT.

The following electric resistances are calculated for pure copper wire. The number of feet to the pound is only approximate for insulated wire.

Number.	Diameter.	Feet per Pound.			Resistance, Naked Copper.			
		Cotton Covered.	Silk Covered.	Naked.	Ohms per 1,000 Feet.	Ohms per Mile.	Feet per Ohm.	Ohms per Pound.
8	.12849	–	–	20	.6259	3.3	1,600.	.0125
9	.11443	–	–	25	.7892	4.1	1,272.	.0197
10	.10189	–	–	32	.8441	4.4	1,185.	.0270
11	.09074	–	–	40	1.254	6.4	798.	.0501
12	.08081	42	46	50	1.580	8.3	633.	.079
13	.07196	55	60	64	1.995	10.4	504.	.127
14	.06408	68	75	80	2.504	13.2	400.	.200
15	.05707	87	95	101	3.172	16.7	316.	.320
16	.05082	110	120	128	4.001	23.	230.	.512
17	.04525	140	150	161	5.04	26.	198.	.811
18	.0403	175	190	203	6.36	33.	157.	1.29
19	.03589	220	240	256	8.25	43.	121.	2.11
20	.03196	280	305	324	10.12	53.	99.	3.27
21	.02846	330	390	408	12.76	68.	76.5	5.20
22	.02535	450	490	514	16.25	85.	61.8	8.35
23	.02257	560	615	649	20.30	108.	48.9	13.3
24	.0201	715	775	818	25.60	135.	39.0	20.9
25	.0179	910	990	1,030	32.2	170.	31.0	33.2
26	.01594	1,165	1,265	1,300	40.7	214.	24.6	52.9
27	.01419	1,445	1,570	1,640	51.3	270.	19.5	74.2
28	.01264	1,810	1,970	2,070	64.8	343.	15.4	134.
29	.01126	2,280	2,480	2,617	81.6	432.	12.2	213.
30	.01002	2,805	3,050	3,287	103.	538.	9.8	338.
31	.00893	3,605	3,920	4,144	130.	685.	7.7	539.
32	.00795	4,535	4,930	5,227	164.	865.	6.1	856.
33	.00708	–	6,200	6,590	206.	1,033.	4.9	1,357.
34	.0063	–	7,830	8,330	260.	1,389.	3.8	2,166.
35	.00561	–	9,830	10,460	328.	1,820.	2.9	3,521.
36	.005	–	12,420	13,210	414.	2,200.	2.4	5,469.

Wire Belt. Machine straps of wire, as a substitute for leather, are being made.

The belts are made of the best crueible steel wire, in transverse network of 1 to 10 wires, in any desirable length or width. The two ends of the strap are joined like the middle, so that there is no beginning and no ending, the belt forming an endless band. All the wires run parallel only across the width, in such a manner that one wire catches into the other like a spiral, a continuous, densely woven chain being thus produced, the movability of which is so great as to enable it to go round the smallest pulley. The straps are also made with leather or elastic lining, or bordered with leather, elastie, hemp, hair-tape, or any other material, also its interstices filled with gutta-percha, to supply elastie bands with cotton web, and to prevent their stretching. The tightening of the strap — shortening of the chain — which is only necessary once, namely, when put on by means of a strap key, may be effected very easily and very quickly by taking out any desirable number of wires, and again joining the two ends in the same manner by twisting in the required number of wires.

Wire Book'-sew-ing. In this system of book sewing the book is "sewed flexible" upon tapes or wide bands (sawing the signatures being entirely dispensed with), and the work is equally well done upon all classes of books.

Every signature is sewed "all along" by independent tinned-wire staples, uniting them firmly to the tapes or webbing, thus securing the utmost strength and durability in addition to the valuable feature of thorough flexibility.

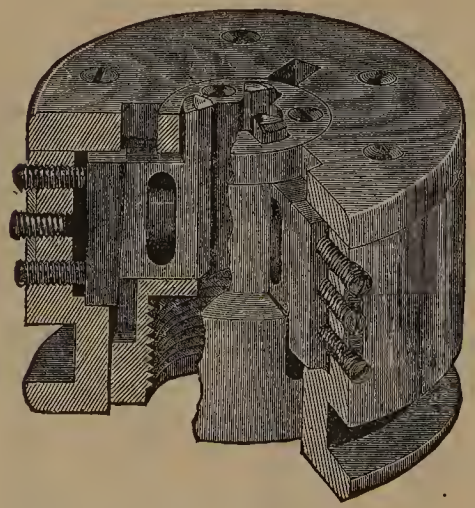
This system is equally adapted to all grades of edition and school book binding, from the cheapest to the most costly full bound books. Also for all classes of blank books, music books, and pamphlets of one or more signatures.

Wire Cut'ting Scis'sors. A double pivoted projecting slide shears for use where there is not play for the common single pivot shears.

Wire-feed'ing Chuck. A screw machine, Fig. 2539. It has an adjustable chuck and wire-feeding apparatus. It is used for making the smallest screws of sewing machines, guns, etc., making from 1,000 to 3,000 screws per day. The chuck is operated while in motion, and the wire is fed through it automatically when loosened, without stopping for each screw. It is adjustable to any sized wire from $\frac{1}{8}''$ to 7-16″ diameter.

It has a hollow cylinder with an outer sleeve sliding upon it. The cylinder contains three jaws fitted to slide in slots which converge to the center; the inner sides of the jaws are parallel with the axis of the chuck, the outer sides of

Fig. 2539.



Wire-feeding Chuck.

the jaws are slightly inclined toward the axis, making each jaw a wedge. The chuck is attached to the machine by screwing the cylinder upon the tubular spindle. The sleeve contains three shoes, fitted into deep cavities which correspond in position to the slots in the cylinder. In the circumference of the sleeve are adjusting screws, so placed that when screwed in their points bear against the outer sides of the shoes until they conform, each to the inclination of its respective jaw in the cylinder. Each shoe has a pair of these adjusting screws, which may be fastened, after being adjusted to the wire, by a pair of set nuts which are tightened by a cone-shaped screw. When the sleeve is moved upon the cylinder toward the spindle, the shoes, acting on the inclined sides of their respective jaws, force them straight toward the center until they grasp the wire. The sleeve is operated by a fork-lever by pins projecting into a suitable groove in its circumference.

Wire Fence. Wires or strips of metal armed with barbs and stretched on posts.

It is nearly fifty years since experiments with wire fencing began to be made, and twenty-five years since it began to be much used. The method promised great economy, both in first cost and in the saving of ground space. Besides, the wire fence was less liable to be blown down, and it would not occasion snow drifts. On the other hand, it was soon found that it was rapidly corroded by the weather, and being inconspicuous was liable to be run down by cattle and horses. When "galvanized," the wire was more durable and more easily seen; and in spite of its inability to stop unruly cattle, wire fencing became widely adopted, particularly in the West, where it is estimated, as many as 150,000 miles of plain wire fencing have been set up since 1850. To make wire fencing stock-proof several devices have been invented and patented during the past ten years, to provide for arming the fence with cattle-repelling spines or barbs of metal.

The "*Holyoke Manufacturer*" states that during the four years the first barbed wire was put upon the market the sales amounted to between fourteen and fifteen thousand tons, and the demand has rapidly increased both at home and abroad. There are several manufactories, and in one instance the works cover three acres and give employment to 1,200 men. The wire is made from Bessemer steel, and is drawn in the usual way. The "galvanizing," or zinc coating, is done by heating the wire in suitable furnaces and drawing it from them, first through tanks of acid, and then through tanks of boiling zinc. A thin and even coating of zinc adheres to the wire, giving it both a handsome finish and a perfect protection from the chemical action of the atmosphere. The barbing is done by automatic machinery. These machines, as described by the "*Manufacturer*," are good specimens of American mechanism, and do their work with lightning-like rapidity, yet with mathematical accuracy. One of the main wires passes through the machine longitudinally. A second wire is fed into the machine at right angles to the first. At each revolution of a certain disk or wheel, the sharp end of wire number 2 is twisted firmly around number 1, and cut off so as to leave a sharp point on the incoming wire as before, while the bit of pointed wire cut off remains as a steel thorn attached firmly to wire number 1. This wire, thus armed with barbs at regular intervals, passes on to a revolving reel, where it is met by wire number 3, — a plain wire without barbs, — and by means of the reel motion is loosely twisted with it. The completed fence wire is thus really a two-strand steel rope, armed with barbs projecting in every direction. The great advantage, besides additional strength, that is secured by the second strand and twist, is an automatic adjustment to changes of temperature. When heat expands the metal the twist simply loosens, and when cold contracts it the twist tightens — all without altering the relative length of the combined wires. The reels upon which the finished product is woven are light, strong, wooden ones, suitable for shipping, and provided with cross-pieces at the ends, on which they can stand, and the barbed wire be protected from injury. Each of these barbing machines turns off 1,200 lbs. of barbed wire a day.

At present wooden posts are usually used as supports for the wire in putting up the fence. But it is believed that iron posts will sooner or later supplant the wood. For study, with a view to new and useful improvements the subject of metallic fences is a promising one for inventors. The demand increases not only with the decay of the old wooden fences, but also with every acre of new land that is opened up to cultivation.

Wire Find'er. (*Electricity.*) An instrument for testing insulation of wires. It has a short ear tube, with ferrotype diaphragm, which is placed in proximity to a magnet which holds the wire between its poles. — *Gott.*

"*Journal Soc. Teleg. Engineers*" . . * vi. 522; * vii. 77.

Wire Gage. An adjustable gage for measuring the diameter of wire, iron, etc.

Wire gage, on a standard * "*Scientific American*," xlii. 233.

Wire-han'dle Ma-chine'. (*Sheet Metal Working.*) A machine for straightening wire, forming it into oval or oblong handles, from 2″ to 3″ long, such as are used on petroleum cans, dripping pans, etc. No. 148 of "*Bliss's Catalogue*," 1881.

Wire In'stru-ments. (*Surgical.*) Instruments for manipulating wire in surgical practice. The list includes —

Wire adjuster.	Suture wires.
Needles.	Wire twister.
Shot compressor.	

Wire Lath. A wire screen or netting that is applied in the place of wooden lath for holding plaster. It is claimed to be more secure against fire.

Wire Meas'ur-ing, Form'ing, and Cut'-ting. (*Sheet Metal Working.*) A machine for preparing wire for use in making up sheet-metal ware.

Bliss's automatic machine is adapted to straighten wire from the coil, cut it off in lengths not exceeding 72″, or form it into rings of from 4″ to 20″ diameter, suitable for pans, kettles, pails, brackets, etc., or into half-circles for pail-handles, etc.

It is driven by power, quite automatic, and works wire up to ½″ diameter.

Wire Nail. A round nail made of wire, and used for attaching molding, metallic roofing, etc.

Wire nails, American . "*Iron Age*," xix., March 15, p. 24.

Wire Pan. A cake-pan with wire screen bottom.

Wire Pla'ting. Immerse in sulphuric acid in which a piece of zinc is suspended. Then place in contact with a plate of zinc in a solution of water (100), tartaric acid (2), chloride of tin (3), soda (3). Let it remain 2 hours, and polish by passing through a draw-plate. — *Dr. Heeren.*

Wire Rope. Commodore Shufeldt has recently ordered the proper authorities of the Boston navy yard to make several 7″ steel wire hawsers. These will probably be the largest wire ropes ever made. The navy department has use for immense hawsers to tow monitors and vessels in distress. They are put on board the men-of war for use when required. The usual appliance is a 12″ hemp rope, but it swells when wet, and gets very heavy by absorption of water. The steel wire hawsers will be 5″ less in diameter, much lighter, non-absorbent, more pliable and durable, and in every respect better. This is a curious, and, in fact, wonderful advance in the application of steel and iron to commercial uses. A hemp hawser 12″ thick is a wonderful thing in itself, but a steel wire hawser 7″ in thickness, better answering the same purpose, is something fruitful of thought to the student in ship building and rigging.

Stahl's "Transmission of Power by Wire Ropes."
Hildenbrand's "Cable-making of Suspension Bridges, as exemplified in the East River Bridge."

Wire Ropes, paper on, by G. L. Abegg	"*Scientific American Sup.*," 2094.
Wire rope, wear of . .	"*Scientific American Sup.*," 86.
Steel, tests, Engl. . .	"*Scientific Amer.*," xxxvii. 88.
Transmission . . .	* "*Van Nostrand's Mag.*," xvi. 68, 166, 225.
Transportation, Reading Iron Works . .	"*Scientific American*," xli. 40.
System, stationary .	* "*Manufact. and Builder*," xii. 59.
Wire ropes *vs.* chain cables	"*Iron Age*," xxi., June 6, p. 18.
Wire rope *vs.* chain cable	"*Iron Age*," xxii., Oct. 24, p. 11.
Ships cable apparatus. *Bullivant*, Br. . .	* "*Engineering*," xxix. 264.

Wire Rope Con-vey'ance. A system of aërial transit on suspended wire ropes has been established to connect the gasworks at Hanover with the neighboring coal station on the Hanover Altenbeck Railway, for the supply of coal to the works. The line crosses the Limmerstrasse and the river Ihme, and is about 625 yards in length.

There are 2 iron wire ropes placed 5′ 10″ apart, and employed respectively for the carriage of loaded and of empty wagons. They cross the Limmerstrasse at a height of 23½′, and the river at about 30′. The cables are respectively 1.12″ and 1″ in diameter, and are constructed of wire of 4 millimeters, about 1-6″, in diameter. They are supported on pulleys at intervals of 24 yards, except in crossing the river, on a span of 57 yards. Resting on pulleys, they are free to expand or contract. They are kept taut by weights of 5 tons and 4 tons respectively.

The wagons are drawn by means of a 9-16″ endless wire rope, supported on rollers at intervals of 60 yards, and driven by a 6-horse steam engine at a speed of 3 miles per hour. The wagons are constructed of sheet-iron, and are capable of holding 3 hectoliters, or 106 cubic feet of coal; they are suspended from the carrying ropes on 2 grooved wheels, one in advance of the other, between which the attachment of the wagon is made. The bodies of the wagons are swiveled, so that they may be easily emptied. They follow each other at intervals of about 60 yards. Allowing for delays, the quantity of coal carried at no time exceeds 180 tons per day of ten hours, and is frequently less, the average delivery being only 135 tons.

Wire Rope Thim'bles. A curved metallic eyelet for protection of the rope from wear.

Wire Rope Tow'age.

The ferry-boat, Waag, is a vessel of 120′ in length, 23′ beam, and 6½′ depth of hold, and draught is of 2½′, is propelled by "overhauling" a chain which lies along the bed of the river between Vienna and Pressburg. The same method is adopted on the Elbe and on other rivers of Europe for towage. The chain is laid on the river-bed, from end to end of the route. The steamer is provided with a winding-drum instead of paddle-wheels, and is thus fitted to haul in the chain at one end of the vessel and to pass it off at the other end.

This method of propulsion, where practicable, is claimed to be more economical of power than the ordinary methods, especially where, as in towing, the losses by slip and by oblique action of the paddle-floats become very serious.

Wire Rope Trans-mis'sion. The use of a round, endless wire rope running at a great velocity in a grooved sheave, in place of a flat belt running on a flat-faced pulley, constitutes the "transmission of power by wire-ropes."

Remarks on same by *Roebling*	* *Cooper's* "*Belting*," 253.
Achard	* *Cooper's* "*Belting*," 260.
Telodynamic system, *Hirn*	"*Prac. Mech. Jour.*," March, 1867, 358.
Professor Barnard . .	"*Report Paris Exposition*," 1867.
Wire rope driving . .	"*Manuf. & Builder*," Feb., 1869, 38.
Rope gearing	"*Newton's Journal*," xxi. 46.
Durie	"*Iron*," London, Oct. 28, 1876.
Wire ropes as connecting rods	* *Cooper's* "*Belting*," 285.

Wire Spring Ma-chine'. A machine for making spiral wire springs.

The wire is first seized by a pair of rollers, one of which has a groove and the other a corresponding milled projection. It is passed under a guide roll, the position of which may be adjusted according to circumstances, and is then carried between a second roller and a guiding sheet which throws it forward. The position of the guide roll determines the diameter of the spiral spring, while the deviation of the second roller and guiding sheet from a position parallel to the first pair causes the spring to become spiral. This deviation is automatically regulated, and the machine is so constructed that when a double spiral has been finished the wire is cut at the proper time.

Wire Test'ing Ma-chine'.

The wire to be tested is held by two clamps, which are drawn apart by a screw and hand wheel attached to one. The other acts upon a long lever, to the longer arm of which a fine chain is attached, which is so connected with a weight that its tension increases in proportion to the movement of the lever. A rod which carries a pencil is attached to the lever, and by a spring the pencil is made to travel along a straight guide-piece. The paper upon which the line is drawn is moved perpendicularly to the direction of the wire through the agency of cog-wheels and a toothed rod. The

ratio of the two movements is so chosen that a curve is the result, the abscissas of which, if multiplied by ten, yield the elongation of the wire, while the ordinates register the tensile strain.

See also "*Scientific American*," . . xxxix. 211.
"*Iron Age*" . . . . . xxii., Nov. 21, p. 1.
Wire testing machine, *Riehle*, . * "*Iron Age*," xx., July 19, p. 9.

Wir'ing Press. A press for wiring pieced tinware. — No. 33 of "*Bliss's Catalogue*," 1881.

Withe. The metal rings that embrace the mast, boom, or gaff, and which have eyelets through which to reeve the ropes.

Wol'las-ton Bat'te-ry. (*Electricity.*) A trough battery; an improvement on Cruikshank's in which the cells are of glass and the plates are attached above to a wooden bar. The first plunging battery.

Niaudet, American translation . . . . . p. 15.

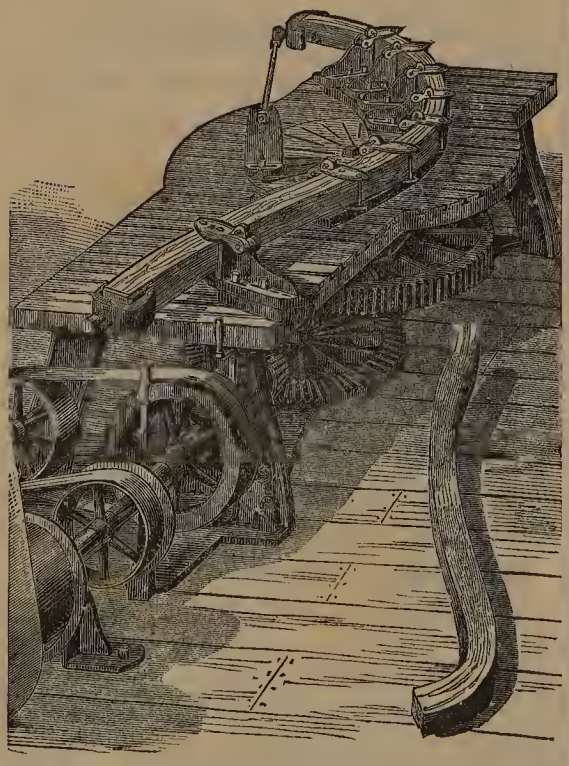
Wood Bend'ing. The bending of hard wood, especially beech, is effected at present by means of hot water or steam, a process somewhat costly as regards fuel, and taking a long time. For overcoming these difficulties the following method has been proposed, chiefly for sieve hoops: —

Two rollers are used, one above the other, the upper one having less velocity, so that it acts by holding back, while the lower extends the wood fibers. When the board, thus bent, leaves the rollers, it is fastened in the mouth of the sieve. The upper roller is fluted, the under one smooth. If two smooth rollers were used a very much greater pressure would be necessary.

Wood Bend'ing Ma-chine'.

Fig. 2541 represents one modification of the machinery for bending timber, which has been brought by a number of years' practice to a high state of utility. It consists of a jointed mold made up of cast-iron sections which have two horizontal projecting arms on the flush side, the one above the other, forming a groove between them for the timbers. The end of each of these sections is circular, and is secured like hinges, interlocking in its adjoining section, and held together by a vertical wrought-iron pin. The sections thus united form a series of joints adjustable to any form, and may be extended to any length. This mold rests upon a

Fig. 2541.



Wood Bending Machine.

circular table with a circular frame beneath, 22′ in diameter. This table, being 3½″ thick and pierced with slotted holes systematically arranged to receive the fastening of the mold, etc., is mounted upon a hollow shaft of cast-iron, 30″ in diameter, and has a screw-thread cut in its outer surface at the lower end, by means of which the table may be raised or lowered and made to bear a part or the whole of its weight on the shaft-bearing. On the lower edge of the table are circular cogs into which a pinion-wheel meshes, and the power applied to the pinion revolves the table. The table has an attachment fastened on the top at its edge, called the head-block, which receives the small end of timbers and plate-strap covering the outside of timbers. The larger end of timbers is confined in a massive cast-iron clamp, which also receives one end of plate-iron strap. This clamp is mounted upon casters, and having a vertical roller on its back at the larger end, is drawn along by means of the plate-strap as the table revolves, the roller in end of clamp bearing against a vertical bulkhead raised from the floor of the building while the timber is being bent into the groove of joint-mold. The clamp, and also the head-block, have screws passing through their ends, by the use of which pressure on the two ends of the timber is communicated. This end-pressure applied to the timber draws the strap straight and to its full tensile dimensions, and when thus brought up against the outside of the timber, the process of bending commences by revolving the table. A mold for bending knees is arranged upon the same table, and is complete in all its parts, details of which it seems unnecessary to describe. The whole machinery is massive and ingenious, although easily operated.

Wood'bu-ry-type.

Where the subject is in line a positive photograph of it (*i. e.*, positive by transmitted light) is made, and from this is obtained a relief in gelatine by the ordinary method, the result being that the hollows of the relief will all be of one uniform depth, this characteristic producing a level or uniform surface in the resulting mold, which is made by impressing this relief into metal by hydraulic or other pressure, or by the method stated in the second part of this invention. Where the subject is in half-tone, as in a photograph from nature, the process is as follows: In printing on the gelatine film there is interposed between it and the negative a photograph on mica or transparent collodion of what is known as mosquito netting, or Brussels net, which breaks up the resulting relief into a multitude of fine square or hexagonal lines. To obtain from this a printing block the means already described are employed, the resulting block in soft metal being capable of giving from 100 to 200 impressions; but where large numbers are wanted this block is electrotyped in the ordinary way. Diffused light is used to produce the block from half-tone negatives, as in that case the light in the parts that represent the whites creeps around the lines, thus obliterating them in that part, and leaving them strongest only in the parts printing dark. Another method is sometimes adopted: A negative of the network is taken by transmitted light, and copied together with the negative, thus producing a positive with the lines already thereon, from which a relief is made as stated.

The second part of this invention may be accomplished as follows: In place of using a thin film of collodion (as is generally used in the process called "Woodburytype") to hold the gelatine of the relief, a sheet of plate glass is first rubbed over with French chalk or ox-gall, and then coated with the bichromatized gelatine solution as now used. When this is dried and ready for use [the side that was next to the glass is exposed for a few seconds to daylight before exposing it under the negative. This has the effect of causing a thin film of gelatine to become insoluble, which after subsequent exposure under the negative will not wash away, but form a support for the photographic image afterwards impressed, thus doing away with the expense and trouble of the double coatings as now practiced. When the gelatine relief is dried in the ordinary way, a thin sheet of tinfoil (same size as the gelatine relief) is attached by gum or other adhesive substance around the edges to the gelatine relief. A stout sheet of plate paper is laid on the back of this and the whole passed through an ordinary rolling press. The tinfoil is by this means impressed into all the details of the relief; but in this state it would be useless to print from. Therefore a shallow metal box is filled with a composition of shellac and asphalt, which on warming becomes soft, but hardens on cooling. This box is placed on a hot plate until the composition softens; it is then placed on the lower plate of the ordinary Woodbury printing press, the foil and relief laid on it, the press closed, and the pressure applied by the under screw. When the composition has hardened the tinfoil adheres to it. The gelatine relief is removed from the foil, and the foil-backed mold used to print from. In place of fixing the proofs by alum or other substance of a like nature, they are varnished with an ordinary varnish composed of shellac and alcohol, giving the print an effect of a photograph on albuminized paper, at the same time protecting the surface from moisture. Sometimes the composition is melted in boxes and used without the foil as a printing mold direct;

when sufficient numbers have been printed the box holding the composition is again heated and can be used over and over again.

The third part of this invention consists in an improved method of printing "Woodburytype" by machinery. This is accomplished as follows: Out of a solid block of iron a cylindrical hole is turned, in which is made to fit very loosely a cylinder of soft metal having a taper or conical hole through it lengthwise. Between the interior of the steel block and the soft metal cylinder the gelatine reliefs are inserted; then, by means of a taper or wedge-shaped spindle (roughened), by hammering or by pressure the soft metal is driven against the iron cylinder, thus impressing the relief on the outside of the metal cylinder, the taper spindle at the same time forming a shaft for the cylinder to be used in the process of printing. This roller, bearing the relief, is then mounted in vertical slots in a frame having a bed of plate glass on which the paper rests, the roller resting on the glass its own weight and being dragged round by the paper itself; or in place of the glass plate the soft metal cylinder is allowed to lie on another fixed or movable roller of metal or glass. The latter may be hollow so as to reduce its temperature in hot weather by a stream of cold water running through it.

Wood'chop-pers' Maul. A large wooden sledge with heavy iron-bound head for driving wedges used in splitting wood.

Wood'en Floor Mat. A sort of grating made of strips of wood, used as a door-mat.

Wood'en Pave'ments.

A rigid foundation of bituminous or cement concrete is universal. This costs more than sand, but it is permanent, and will prevent the blocks from sinking under the wheels. English engineers, in discussing pavements, call the foundation the true pavement, the blocks being the wearing surface only. The "Henson" pavement, with some modifications, is the best for this country. Instead of a layer of tarred paper on the concrete, use a thin layer of pitch, with oil enough in it to make it permanently slightly plastic, setting the blocks upon it while hot and soft, using the strips of tarred felt between the rows, and driving the blocks together. The tarred felt would make a very close joint. Then pour melted pitch over the whole surface, taking care to fill every crevice, and upon this spread fine sharp gravel, which will work into the ends of the blocks and form a surface resembling macadam, and afford a far better footing than wide spaces between the rows, which serve as receptacles for mud and dust. It is easy to keep this pavement clean. No water can penetrate it, so that it will not be injured by frost. The blocks themselves, if creosoted, will not absorb water, and if laid without spaces between the blocks, the drainage will be surface drainage solely, which is of the first importance.

But the pavement would be short-lived if *green* and wet blocks are used. It is not practicable to use, as Mr. North says is the case in London, "wood better seasoned than the pine generally used by house carpenters in this country." Seasoned wood cannot be obtained in sufficient quantities here. But, what is far better, it can be preserved from decay.

No faith can be placed in any method of wood preservation for paving blocks which does not exclude water. The blocks are so short that any soluble preparation is quickly washed out of them, and, if not made waterproof, they are certain to absorb the seeds of destruction from the filth in the streets. The blocks should be well saturated with creosote oil, whose chemical constituents act preservatively upon the fibers of the wood by coagulating the albumen of the sap, while the fatty matters act mechanically in obstructing the pores of the wood and keep the water out. At the same time, as oil cannot be injected into wood full of moisture, the thorough artificial seasoning which forms a part of the process of creosoting as carried on in this country, is as useful to the timber as any of the metallic salt processes.

By thoroughly creosoting the blocks, expansion and consequent throwing out of the blocks is prevented. They will not shrink or expand. The wood is also rendered homogeneous; the sap wood becoming as durable as heart wood. Looking to sanitary considerations, the creosoted wooden pavement is perfect. The carbolic acid contained in the oil is a powerful disinfectant, and as the pavement described will not absorb any deleterious substance from the surface, it has only to be kept clean to maintain the best sanitary condition.

Wooden pavement, Lond. "*Scientific American*," xxxv. 115.
On, (many figures) . * "*Engineer*," xlv. 171, 314.

Wood'en Rail. For wooden rails the best wood is maple, laid with the heart up; hard pine is used in the South.

The simplest form of wooden rail is a stringer cut in 16′ to 20′ lengths, and of such cross-section as the kind of wood or weight of engine requires. 6″ square is usually the best size for stringer, although 5″ face by 7″ depth, is sometimes as good. 4″ face by 6″ depth, or 5″ square, will answer for small engines, if the wood is good; still smaller sizes may be used by placing the cross-ties close together, say 2′ or 2½′ between centers; for large stringers, 4′ between centers will answer. When worn out on top the stringer may be reversed, and when again worn out may be used for ties.

The ties are more easily fitted and laid if made uniform, and of about the same size lumber as the rails; 6″ square is heavy enough. Any cheap lumber not specially liable to decay will do. Ordinary hewn ties may be used, but not being uniform are less convenient for cutting out recesses for rails. They should be at least 3′ longer than the width of the track between rails. The ties must be cut out accurately and uniformly to receive the rails. The recesses should be about 3″ deep, and be at the top face of the tie 1″, and at the bottom of the recess 1½″ wider than the rail. The inner faces of the recesses are perpendicular, and the distance between them is the gage of the track. The bottom of the recess should be level, and ties laid well to afford proper bearing for the stringer.

Wedges made of any cheap wood, or better, of ends of stuff left from rails, are driven on the outsides of rails. They are made of right shape to fit the space left; the reason for making this space wider at the bottom than at the top, is to keep the wedges from working up, so that the rail may be held securely in place.

The stringers must be arranged to break joint on the ties. Both stringers should not break joint on the same tie. The stringers are sometimes sawed off diagonally instead of perpendicularly, so as to lap and be spiked altogether. The cost of lumber for a hard pine wooden road will be about $450 per mile.

With another style of wooden road the stringer is made of hemlock or any cheap lumber, and a maple strip 4″ to 5″ wide and 2½″ to 3″ thick is spiked on to the stringer. By this plan, such a part of the rail as is worn out may be removed without taking up the stringer. The maple strip may be replaced by a T-iron rail considerably lighter than would be required if laid directly on cross-ties; this is preferable to strap iron.

A wooden rail is very slippery when wet, and hard to keep clear of snow and ice in freezing weather. On very bad curves and steep grades a wooden rail is impracticable, and iron must be used.

A locomotive has but one half or two thirds the power on wood that it has on iron; the friction useful for traction is less, and the flange friction is greater. Locomotives for wooden rails should be built very strongly and evenly balanced; the weight should be less, and the drivers larger than for the same size of cylinders on iron rail. A locomotive with six wheels connected, or with four drivers and a two wheel truck, is preferable to a four-wheel engine for wooden rail.

Wood'en Wall Cov'er-ing. A veneer surface for wall paper.

The wood is cut to the thickness of paper, and by a peculiar process stuck on the paper, which serves as a protection against the influence of the walls on the graining and color of the wood. The delicacy of the machinery employed in cutting so thin a veneer may be gathered from the fact that 200 leaves are cut out of an inch of white maple wood, and 125 out of wood with very open grain, such as oak and walnut.

Wood Fa'cing Ma-chine'. A machine used in the manufacture of furniture, sash, doors, patterns, agricultural implements, etc.

It is adapted for planing out of wind, making bevel or square glue joints, facing and edging, surfacing straight, squaring, beveling, etc. The work, as it passes over the tables, needs no dogging or exertion to hold it.

The tables are drawn back or pushed forward, to regulate the cut, by a screw, while the machine is running. The motion of the tables on the wedges, while regulating the cut, secures at the same time a uniform distance from the knives.

Wood Oil.

The curious product of India, called by the English *wood oil* or *Gurjun balsam*, forms the subject of two papers published in the "*Pharmaceutical Journal*," by Messrs. Charles Lowe and Daniel Hanbury. Mr. C. Lowe, who only knew that this resinous liquid is extracted in India, by incisions made in the tree, considers it as a *Copaiva balsam* rendered turbid by a greenish resin held in suspension. The filtered balsam forms a brown and transparent liquid, from which we withdraw by distillation —

Volatile oil	65
Hard resin	34
Water and acetic acid	1

According to Mr. Lowe the volatile oil possesses all the characters of that of copaiva, and the *hard* resin, which he regards as pure *copaivic acid*, free from the *soft* resin, which, according to him, exists in the most part of commercial copaivas, seemed to him to indicate a superior quality as a medicine.

Wood Pre-serv'ing.

The various processes for preserving wood have for their object the prevention or arrest of fungoid growth. This is sought to be accomplished by two main systems; one of which consists in impregnating the wood with a solution of a metallic salt, such as corrosive sublimate, chloride of zinc, or sulphate of copper, and the other includes the several creosote processes. The action of the salts named is purely chemical, and as they are introduced in watery solution, it is evident that subsequent exposure to moisture tends to redissolve them and leave the wood unprotected. Creosoting, while producing the same result chemically, also secures dryness, which alone is sufficient to prevent decay, provided that it can be maintained.

In creosoting, it is essential that the wood should be thoroughly dried, in order to secure complete impregnation, and hence timber is usually seasoned for months before treatment. This is a serious objection, which inventors have attempted to remedy by adding a preliminary dessicating operation. At extensive works at South Boston, Mass., a process known as the Hayford is in use, which consists in drying the timber *in vacuo*, and then impregnating it with creosote oil under pressure. Green timber is fed by a rail track into an air-tight cylinder of boiler iron, 100′ long and 6′ in diameter. This cylinder has been tested by hydrostatic pressure of 200 lbs. to the square inch, and is capable of being hermetically closed. When the charge is in, steam is introduced, raising the temperature gradually, so as not to harden the outside of the wood and prevent the escape of moisture from the interior. Atmospheric air is also forced in at a pressure of from 30 to 40 lbs., to restrain the tendency of the wood to crack. A temperature of 250° to 270° is found sufficient to evaporate the sap, and the whole steaming process occupies from 4 hours for boards to 10 or 12 hours for heavy timber. When it is certain that the sap and vapor have been turned into steam, the direct steam is shut off, and air pumps set to work to free the cylinder from the steam, vaporized sap, and result of condensation. This stage is reached in about an hour. The cylinder being made tight again, and still heated by the coil, a vacuum pump is put in action. Then the creosote oil, previously heated to near the boiling point to render it limpid and penetrating, is introduced under a pressure of 60 lbs., which, added to the drawing power of the vacuum, makes a total pressure of over 70 lbs. to the square inch. The hot oil soon impregnates the wood. If the timber is of very close fiber, the pressure is raised to a higher point. The process completed, the charge is withdrawn and another takes its place.

The process known as "Beerizing timber," takes its name from Sigismund Beer, a chemist of New York City, who discovered that by the use of borax as a solvent the coagulation of sap is prevented, and this without injury to the wood tissues. The obnoxious ingredients being thus removed, the wood is rendered closer in grain and thereby improved in appearance, becomes impervious to decay, and remains unaffected by atmospheric changes.

A recent number of the "*Annales des Ponts et Chaussées*" gives the following information, furnished by the officers of the railway from Hanover and Cologne to Minden. The proportion of pine ties, injected with zinc, renewed after 21 years, was 21 per cent.; beech ties, injected with creosote, renewed after 22 years, 46 per cent.; oak ties, not injected after 17 years, 49 per cent.; oak ties injected with chloride of zinc, after 17 years, 20.7 per cent. The ties which were not renewed appeared perfectly sound. Since 1870 the Emperor-Ferdinand Northern Railway has used only oak ties, injected with either creosote or with chloride of lime.

Hatzfeld recommends, in "*Eisenbahn*," for this purpose the injection of tannin in form of decoctions of substances containing it, as for instance, chestnut and oak bark. The wood is treated with these decoctions in closed vessels at high pressure, and afterwards treated with a solution of the pyroacetate of the sesquioxide of iron. The latter is transformed into a tannate and finally converted into a salt of the oxide by oxidation. This process has now been generally introduced by the larger railroad and telegraph companies in France.

Mr. Lostal, a French railroad engineer, recommends lime as a preservative for wood. He puts the wood to be prepared in large excavations in the ground, and covers them with freshly calcined lime, which is gradually slaked by the addition of water. Wood to be used for mining structures must remain in the lime about 8 days before becoming fully impregnated. The wood becomes exceedingly hard and never rots. Beechwood prepared in this way has been used as material for hammers and other tools in several factories, and is said to have become as hard as iron, without losing its peculiar elasticity. At Strasbourg, lime slacked in a solution of chloride of calcium is used as a fire and weather proof pigment for woodwork.

Wood, preservation of.	"*Scientific American Sup.*," 1890.
Paper by *Jefferson* . .	"*Man. & Builder*," xii. 181, 190.
	* "*Scientific American*," xxxv. 360.
Wood preserving process *Palmer*	* "*Scientific Amer.*," xxiv. 259.
Wood preserving and fireproofing, *Folbacci* .	"*Scientific American*," xl. 67.

Wood Pulp Pa'per.

In wood paper manufacture the split 4′ timber is fed into a circular fan-like hopper provided with swiftly revolving steel knives, which cut the timber into small chips in very short order, when a fan drives them up into the loft, where they are shoveled into two steel digesters holding from four to six tons each. Soda ash, and other chemicals, are introduced, a heavy head of steam is turned on, varying in different mills from 100 lbs. to 200 lbs. pressure to the square inch, and the chips are thoroughly separated. Then the pulpy mass is washed out into vats to drain off the chemicals, and after it has become solid it is again washed out and pumped up into the engines and beaten, and the usual process of paper-making is then gone through with.

Some makers think evergreen woods far preferable, as having a larger and more hardy fiber.

The year 1846 — when the German engineer, H. Völter, began his experiments of using, instead of vegetable fiber from flax and cotton, wood fiber, which he prepared by quite a simple expedient — was the beginning of a branch of industry which is already of great importance to Sweden, since that country possesses just what is chiefly required for it: abundant supplies of fir-forests and large waterfalls. The first factory established on this Völter's system was at Trollhättan, in 1857, and for ten years was the only one of its kind, until here and there in the country they began to establish others, so that in 1870 there were six; but from this time their erection was very rapid till 1873, when there were twenty-seven wood-pulp factories already completed or nearly so; but since that time none have been erected.

The observations and inventions made in this branch of industry have not been unnoticed, and therefore the manufactories are calculated to be worked, partly on the chemical and partly on the mechanical method. The chemical method is as yet so new, that it is difficult to say what development it will enjoy. It is certainly true that in this way a better and more fibrous pulp is obtained, but in proportion to the ground pulp, it is also dearer, especially since caustic soda, which is needed for the manufacture, has considerably risen in price. The grindstones that have hitherto been employed in the mechanical method have as yet been generally obtained from Germany, the cause of which cannot be that the material required for it is wanting in Sweden, but rather at the new-established works they have wished to avoid experiments at first, and hence the stones have been brought from such places, where they have already been practically tried. All the machinery, on the other hand, is now made in the country.

The Swedish wood-pulp manufactories extant at the beginning of 1873, may be divided as follows: —

I. *Mechanical*, new works where 100 horse-power is calculated for each grindstone:

a. Eleven Völter's manufactories with vertical grindstones, and the supplying of the pieces of wood by a screw-mechanism. Of these the oldest (Trollhättan) has twenty stones, of which the greater number are small; but besides, there are several large establishments with from five to six grindstones of from 5 to 5½′ in diameter.

b. Two Hartmann's, with small vertical grindstoues, and supplied by weights.

c. Four Siebrecht's, with large horizontal grindstones, and supplied by hydraulic pressure.

II. *Chemical*, generally provided with two boilers:

Ten manufactories constructed on different methods (Sinclair's, Lee's, Fry's, etc.). The boiling is generally done with caustic soda, in weight about 25 per cent. of the wood, besides, the so-called half-chemical method is applied, consisting in boiling or steaming blocks of wood, and then grinding them in the usual manner. Some of the more recent paper manufactories in the country manufacture from such pulp a kind of paper very good for wrappers and sheathings.

Wood Screw. A square-headed screw with a coarse thread for fastening together wooden frames.

Wood screws.	*Scientific Amer.*," xl. 24.

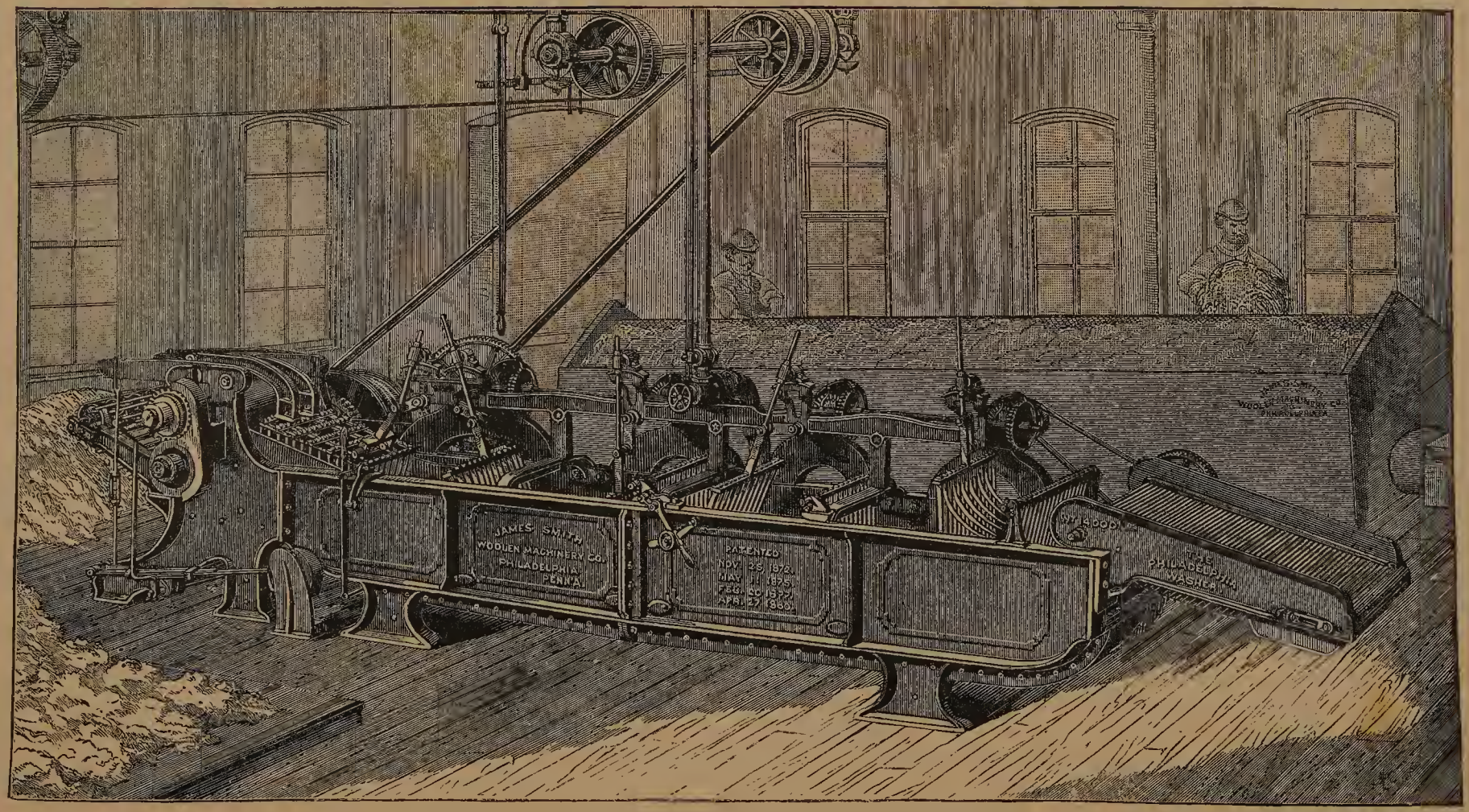


PLATE LVI. WOOL WASHING MACHINE. *See page* 955.

Wood Stain'ing.

In most cases the staiuing of wood may be effected so as to produce very bright colors without any previous preparation, as, generally speaking, the mordants employed have a bleaching action on the wood. But in many cases, in consequence of the quality of the wood under treatment, it must be freed from its natural colors by a preliminary bleaching. To this end it is saturated as completely as possible with a clear solution of 17¼ oz. chloride of lime and 2 oz. soda crystals, in 10½ pints of water. In this liquid the wood is steeped for half an hour, if it does not appear to injure its texture. After this bleaching it is immersed in a solution of sulphurous acid, and then washed in pure water. The sulphurous acid which may cling to the wood in spite of washing does not appear to injure it or alter the colors which are applied.

Red. — The wood is plunged first in a solution of 1 oz of curd soap in 35 fluid oz. of water, or else is rubbed with the solution; then magenta is applied in a state of sufficient dilution to bring out the tone required. All the aniline colors behave very well on wood.

Violet. — The wood is treated in a bath made up with 4½ oz. olive oil, the same weight of soda asb, and 2½ pints of boiling water, and it is then dyed with magenta, to which a corresponding quality of tin crystals have been added.

Blue. — Prepare as for violet and dye with aniline blue.

Green. — Mordant the wood with red liquor at 1° B. This is prepared by dissolving separately in water 1 part sugar of lead and 4 parts of alum free from iron; mix the solutions and then add one thirty-second of a part of soda crystals, and let settle over night. The clear liquor is decanted off from the sediment of sulphate of lead and is then diluted with water till it marks 1° B. The wood when mordanted is dyed green with berry liquor and extract of indigo, the relative proportions of which determine the tone of the green.

The wood, mordanted, as above directed, can also be dyed a fine blue with extract of indigo.

Yellow. — Mordant with red liquor and dye with bark liquor and with turmeric.

Besides the aniline colors, cochineal gives a very good scarlet red upon wood. Boil 2 oz. of cochineal, previously reduced to a fine powder, in 35 oz. of water for three hours, and apply it to the wood. When dry, give a coating of dilute chloride of tin, to which is added a little tartaric acid, 1 oz. of chloride of tin, and ½ oz. of tartaric acid in 35 fluid oz. of water. If instead of water the cochineal is boiled in a decoction of bark (2 oz. bark to 35 oz. of water), and the chloride of tin is used as above, an inteuse scarlet, and all shades of orange, may be produced according to the proportions.

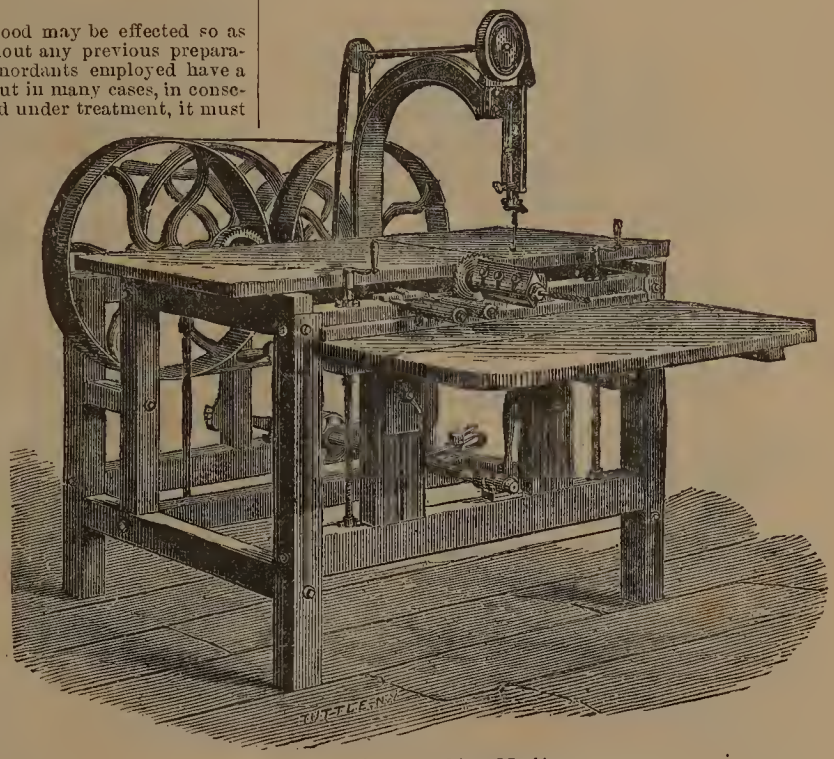
Brown. — Various tones may be produced by mordanting with chromate of potash, and applying theu a decoction of fustic, of logwood, or of peachwood.

Gray. — Grays may be produced by boiling 17 oz. orchil paste for half an hour in 7 pints of water. The wood is first treated with this solution, and then, before it is dry, steeped in a beck of nitrate of iron at 1° B. An excess of iron gives a yellowish tone; otherwise a blue-gray is produced which may be completely converted into blue by means of a little potash.

Black — Boil 8¾ oz. of logwood in 70 oz. of water, add 1 oz. blue stone, and steep the wood for twenty-four hours. Take out, expose to the air for a long time, and then steep for twelve hours in a beck of nitrate of iron at 4° B. If the black is not fine, steep again in logwood liquor.

Wood'work-ing Ma-chine.' The Greenwich Combined Woodworking Machine, Fig. 2542, is a machine for circular and scroll sawing, surface molding, planing, mitering, and boring.

Fig. 2542.



Woodworking Machine.

The scroll saw has a positive motion, and there is a steel bearing at the back of the saw that steadies and keeps it firmly in its place when running, so as to enable those inexperienced in the use of the scroll saw to do true work. Any desired rake can be given to the saw, by turning the hand-screw behind it.

The cutting edges on planing and molding machines should move at a velocity of 6,000′ per minute. Where hard wood exclusively is worked the feed should be one fourth less.

Teeth of circular saws should travel about 9,000′ per minute.

Teeth of band-saws should travel about 4,000 per minute, to obtain the best results.

See English patents of *Sir Samuel Bentham*, 1791 and 1793.

Joseph Bramale, 1802.

Hatton, 1776.

Samuel Miller, 1777.

Molesworth's pamphlet on "*The Conversion of Wood by Machinery*," Proceedings Inst. of C. E., London, 1857.

Prof. Rankin on machine tools.

Prof. Willis's lecture before the Society of Arts, 1852.

Woodworker, variety.
Fay & Co. . . . . * "*Engineer*," xli. 463.
Fay . . . . . * "*Scientific Amer.*," xxxiv. 114.
Woodworker, Universal.
Fay . . . . . * "*Scientific American*," xxxv. 118.
Bentel, Mayedant & Co. . . . . . * "*Engineer*," xxi 409.
Fay . . . . . * "*Scientific American*," xxxv. 147.
* "*Engineer*," xlv. 439.
Fay & Co. . . . . * "*Man. & Builder*," viii. 270.
Wood working machines, Power, *Barnes*, Fr. . * "*Manufact. & Builder*," x. 55.
Wood working machinery, *Woods* . . . * "*Manufact. & Builder*," ix. 136.
Works, *Rogers* . . . * "*Scientific American*," xlii. 31.
Wood working machines French . . . . . * "*Scientific Amer.*," xxxvi. 210.

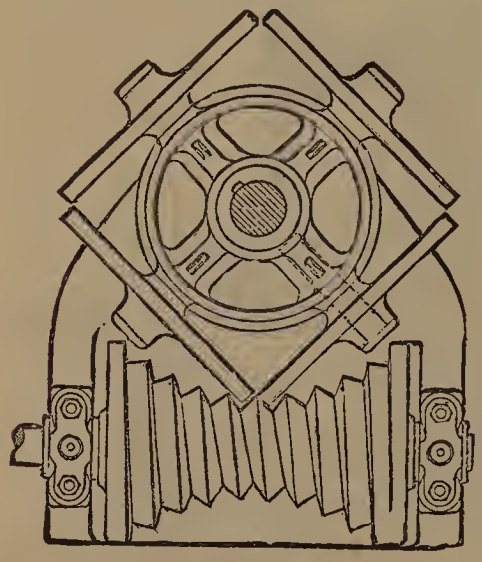
Wool "Ex'tract." Wool recovered from worn mixed fabrics where the cotton has been destroyed by a chemical process. In the year 1865 the amount of *extract* used was 5,000,000 lbs.

Wool Hat Ma-chin'e-ry. See HAT MACHINERY; also the various special machines under the caption HAT, as HAT FULLING MILL; HAT BLOCKING MACHINE, etc., etc.

Wool Wash'er.

Plate LVI. represents "Smith's" wool washer. The ducker is attached to the rake, next to the feed apron, and serves to duck or push down the stock into the liquor. The stock is forced under by the curved lines, as it drops from

Fig. 2543.



Worm Gearing.

the feed apron, and it is carried at once to the bottom of the bowl. A valve outlet is so arranged that the stock cannot wind about the valve levers.

Steam has access to the water through numerous small holes pierced through a pipe extending lengthwise of the machiue, under the false bottom, tbus distributing the heat. The water is supplied through a chamber in the side of the bowl, obviating any splash in filling it. A double-acting carrier takes the stock up and delivers it to the press rolls. The carrier has teetb, the rear rank of which are nearly as long as those of the stirrer fork. On its forward movement the carrier engages with the stock and takes it up over the face of the chute.

The cone pulley on the main driving mechanism is driven from a like cone pulley on the counter shaft.

Wootz. The genuine Wootz steel comes from India in three forms, namely, in bullet-shaped pieces of a ccrtain weight as they cool in the pots, and which comes from Calcutta: in cakes of 2½ lbs. from Bombay: and in cylindrical rods of about the same weight from Golconda. See "*Mech. Dict.*," pp. 2364, 2818.

Work'er. (*Leather.*) A two-handled blunt knife curved to suit the inclined face of the beam, and used to scrape the hides.

Work'ing Glove.

Ordinary gloves used in husking corn and doing other similar kinds of work, wear out first upon the tips of the fingers and thumb, and upon the ball of tbe thumb. To obviate the unequal wear, and to render the glove more serviceable, a glove has been devised the body of which is of the ordinary form and materials, and to its inner or palm side are attached pieces of cloth upon which, in places subjected to the greatest wear, there are surfaces that are covered with a protccting coating of sand aud rubber. Instead of applying thc protective coating to the cloth in tbis manner, it may be applied directly to the face of the glove.

The rubber coating protects thc glove and renders it waterproof at the points to which it is applied, and the sand assists materially in removing the husks from corn; it also renders tbe glove more effective in grasping objccts of any description.

Worm Gear'ing. Hawkin's gearing, Fig. 2543, is a new modification of worm gearing.

It has an arrangement for transmitting circular motion in either direction. It is a plan in which the spiral worm is made of such a length that the edge of one roller does not cease contact until the edge of the next comes into contact; a wheel carries four rollers which turn on studs, the latter being secured by cottars; the axis of the worm is at right angles with that of tbe wbeel. Tho edges of tbe rollers come near together, leaving sufficient space for the thread of the worm to fit between any two contiguous rollers. The pitch line of the screw thread forms an arc of a circle, whose center coincides with that of the wheel, therefore tbe thread will always bear fairly agaiust the rollers and maintain rolling contact therewith during the whole of the time each roller is in gcar, and by turning tbe screw in either direction the wheel will rotate.

Worm'ing. (*Nautical.*) Laying of yarn in the cant of a rope to bring it to a rounder surface before *parceling* or *serving*, which see.

Worm'-thread Tool'-gage. A gage that furnishes a correct guide of form for tools used in turning the threads of worms, when the worm wheels have been cut to correspond. The figures on the gage represent the number of thrcads per inch of the worm. The slots in the gage are also of the proper depth for their respective threads.

Wor'sted. (*Fabric.*) From Worsted, in Norfolk, England. The wool-workers of that place adopted a comb in carding and a harder twist in spinning, which gave the name to its products.

Wound Ex-plor'er. (*Surgical.*) An electric sound used in searching for bullets.

The elcctric wound cxplorer of M. Trouvé, of Paris, was presented to the Academy of France in 1867.

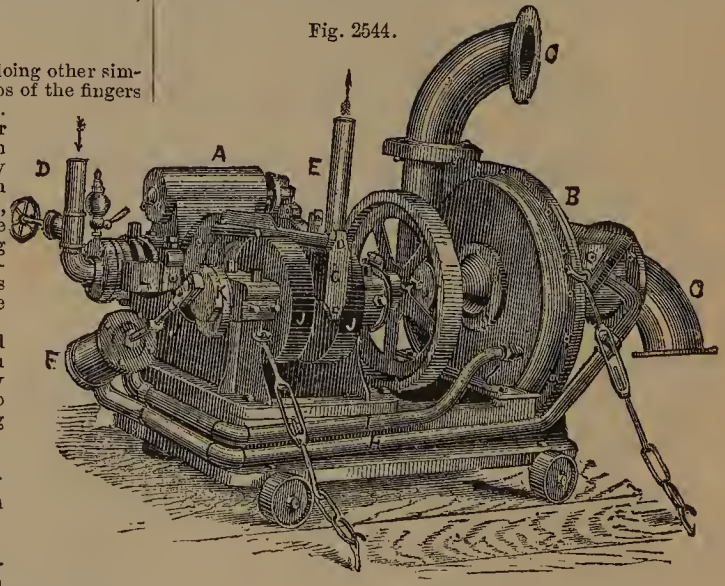
Wo'ven Wire Belt'ing. Woven steel wire belting is claimed to transmit power well, to operate without lengthening, and to run smoothly because there is no overlapping at any place. The spirals of wire are woven across the belting, so that three, four, or more spirals form one link. The space between two links is, besides, filled up with a cross-piece, so that the closely woven netting of spiral wire forms a band of great strength and flexibility. It is faced and lined with rubber or leather.

Wreck'ing Pump.

The "Heald" steam pump, Fig. 2544, is for use in pumping out wrecked vessels. It is actuated by an oscillating engine of short stroke. The rolling valve within the valve-chamber on the cylinder is worked by an eccentric from the engine-shaft. The guides for relieving the strain on the piston-rod project from the head of the cylinder, and are partially concealed by the counter balance-wheels. There is a force-pump used for priming the main pump through the pipes.

It is operated by friction-wheels, connected or disconnected by a lever. There are swiveled elbows for suction and discharge, turning in any direction and detachable. There is a

Fig. 2544.



Wrecking Pump.

device in the cross-head of the guides for taking up the slack occasioned by wear of the parts. There is also a balc,

with tubular trunnions, in conjunction therewith for securing a better connection of the steam-pipes with the engine.

Wrench. A lever having jaws at one end adapted to catch around the head of a bolt, or around a nut to loosen or tighten the nut on the bolt.

One jaw is often made adjustable. The "Alligator" has ratchet teeth cut diagonally across one jaw, thus enabling it to bite with three teeth at once. A single wrench will hold many sizes of nuts or bolts.

Robinson's crank-wrench and bit-brace is a combination of the wrench, crank, and brace. It is intended in its crank movement to provide a wrench that will not require to be readjusted at each half-turn; a rotary wrench that turns without removal till the nut is advanced to its place.

As a brace it is clamped to the bit by the set-screw that drives the movable jaw and holds the same. As a vise it is inverted and secured to the bench by a clamp.

The "Baxter" wrench has adjustable sliding jaws that are connected by a set screw that contracts them to their embrace.

The "Rogers" wrench is an elongated ring bar device, diverging to a larger capacity at one end so as to hold nuts of all sizes. A bevel rigidifying sleeve that clamps to the square of the nut, holds it while being operated on.

Wrench, *Squire*	*	"*Scientific American*," xxxv. 51.
Port	*	"*Scientific Amer.*," xxxiv. 131.
Bedell	*	"*Scientific Amer.*," xxxiv. 182.
Bemis & Call	*	"*Iron Age*," xxi., June 27, p. 11.
Rouse	*	"*Iron Age*," xxiii., June 26, p. 9.
Phillips	*	"*Scientific Amer.*," xxxix. 8.
Automatic, *Birch*	*	"*Scientific American*," xli. 278.
Moukey, *Johnson & Co.*	*	"*Iron Age*," xxi., March 28, p. 11.
Screw, *Coes*	*	"*Iron Age*," xxi., May 2, p. 25.

Wrench Han'dle. A double-arm wrench for use with dies for cutting threads, and other purposes.

Wri'ting. For restoring faded writing. Brush it over with a solution of ammonium sulphide.

M. Von Bibra, in the "*Journal de Chimie*," describes a method of restoriug the writing of old manuscripts and the colors of oil paintings which have faded or become discolored by age. For the manuscripts, the writing is treated with recently prepared ammonium sulphide, and in the course of a few momeuts the characters become distinctly visible. Any excess of the reagent must be removed by washing in cold water, and the manuscript is then dried, either by gentle heat or by means of blotting-paper. Should the characters fade again after this treatment, they should be submitted to the action of a solution of tannin. As it is only in far distant times that carbou writing fluids were used, and as nearly all the more recent manuscripts have been written in gallate ink, it may be said that M. Von Bibra's method can be employed with any writings. For the oil paintings, after having dusted them with a wash leather, tbey are washed with a sponge and fresh water; they are then covered with a solution of soap (the author recommends shaving-soap, probably that which is known in France as *crême de savon*), which is wiped off with a brush after the lapse of from eight to ten minutes, aud when the soap has been completely removed the painting is allowed to dry. It is then rubbed with a soft linen cloth soaked iu nitro-benzine, which restores the luster. Lastly, a little olive oil is passed over it, and it is varnished with a white varnish.

Wri'ting Tel'e-graph. Cowper's writing telegraph, unlike previous autographic systems, does uot depend upon electro-chemical decomposition. A pencil is moved at the sending station, and at the receiving station a pen charged with ink describes the same movements.

The sendiug apparatus consists of a pencil under which a continuous band of paper is drawn by clockwork. Attached to the peucil are two light rods placed at right angles to one another. When the pencil is moved, the curves made in forming tbe various letters cause the ends of these rods to make a series of lateral and longitudinal movements. These ends of the rod pass over the ends of a bundle of brass plates, connected each with a resistance coil, so that their movements over them transmit to the distant station currents of varying intensity. These are utilized at the receiving station in the following manner: There are two strongly magnetized needles on delicate bearings, forming movable eores iu coils, which are placed between the poles of four permanent magnets. These magnetized needles are also placed at right angles to oue another. Fastened to the point of each is a thread, and these two threads cross one another and are knotted together at the point of intersection. At this central point they carry a tiny pen, consisting of a glass hair-like tube of syphon form, its upper end dipping into a little cistern of limpid analine ink. A traveling slip of paper passes slowly beneath this pen, and as it moves a straight line of ink is drawu upon it. But directly the operator at the sending station begins to write with his peucil, the varying currents thus caused, in the manner indicated, impart varying degrees of strength to the magnets surrounding the needles. The needles are consequently endowed with movements of greater or less amplitude. The crossed threads are pulled by the moving needles, and the curves of the writteu letters are reproduced by their combined action. By this machine the question of sending autographic messages, so important iu many government and commercial affairs, has been solved iu a simple and ingenious manner.

X.

Xan'the-ine. (*Chemical.*) A yellow substance soluble in water, which forms the coloring matter of some yellow flowers.

Xan'thi-an. A kind of marble found near Xanthus iu Asia Minor.

Xan'thid. (*Chemical.*) A supposed compouud of xanthogen with some basifiable or acidifiable element.

Xan'thite. A mineral occurring in rounded grains and foliated masses, of a yellow color, and translucent, consistiug chiefly of silica, alumina, lime, oxide of iron, oxide of manganese, and magnesia.

Xan'tho-core. A mineral of a dull red or brownish color, consisting chiefly of sulphur, arsenic, and silver

Xan'tho-rite. A variety of allanite, of a yellowish color, and containing much water.

Xe'bec. (*Nautical.*) A small three masted vessel used in the Mediteranean Sea. With a fair wind in good weather, it carries two large square sails; when close hauled it carries large lateen sails.

Xy-lan'thrax. Wood-coal, or charcoal. So called in contradistinction from mineral coal.

Xy'lite. (*Mineral.*) A mineral resembling xylotile, of a brown color and asbestiform structure, and consisting chiefly of silica, sesquioxide of iron, lime, magnesia, and water.

Xy'lo-phone. An instrument to determine the vibrative properties of woods and metals.

M. Decharme experimented a short time ago on the musical sounds given by metallic bars of different metals having the same dimensions. He has made similar experiments on different kinds of wood. Notwithstanding the diversity of the kiuds of wood examined (38 species and 14 varieties) they were all found to give sounds comprised in the interval of an octave. The most grave sound is mi_4, given by box; the highest mi_5, given by Northern fir. M. Decharme gives a list of the sounds emitted by different woods between the two extremes. The range of sounds from the metals extended from 690 vibrations for lead to 2,762 vibrations for aluminum. Sounds from wood are comprised between those for brass, 1,303.62, and aluminum, 2,762. This is no doubt partly accounted for by the much less range of densities in woods than in metals. Still there are anomalies. Thus, the willow, which, after the poplar and certain firs, was the lightest of the woods experimented on, gives the same note (sol_4) as ebony, which is the heaviest after the tea and the palisander. It was difficult to appreciate the intensity and the duration of the sounds, but palisauder, logwood, waluut, and acacia were in the front rank iu this respect. (The durations of the sounds did not exceed the fractiou of a second 0.5 to 0.7, for the most sonorous palisander.) Northern fir and poplar had the clearest timber.

Y.

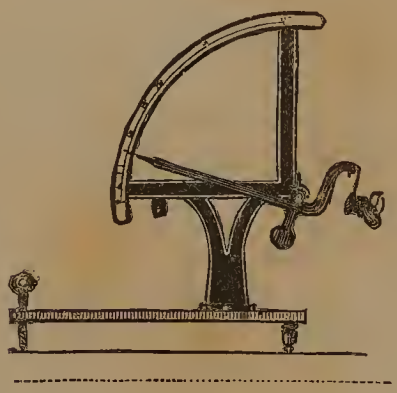
Y. Or fork, for holding boring bars by the square. See also CLAMP.

A branching pipe having a bifurcation like the letter Y. See BRANCH.

One of the forked pieces that support the pivots of a transit instrument, of the telescope, or the theodolite, etc.

Yarn As-sŏrt'er. Fig. 2545 represents an apparatus for the assortment and graduation of yarns.

Fig. 2545.



Yarn Assorter.

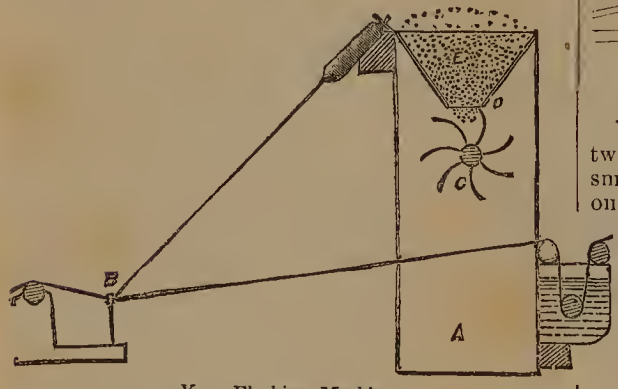
A skein is placed in the cup suspended from the rear arm of the pointer, when the number is immediately indicated on the graduated scale.

Yarn Flock'ing Ma-chine'. *Le Jacquard* gives a description of an apparatus which, though crude, is intended to produce a new effect in the appearance of certain yarns for fancy goods.

The yarn to be manipulated, according to this plan, is passed through the apparatus before being doubled. One thread passes direct from a cop or hobbin, and the other through a trough containing water or a thin solution of size. The latter is then carried through a box, provided at its upper end with a hopper filled with particles of colored wool, broken fiber from rag-ends, feathers, or any desirable substances, which are allowed to fall through an opening at the bottom of the hopper, and upon a revolving fan-wheel which pulls it out and disperses it, throwing it upon the thread passing through the lower part of the box.

In a modification of this arrangement a traveling apron

Fig. 2546.



Yarn Flocking Machine.

runs under the threads, and carries any superfluous flocks or feathers back into the hopper. In this manner any foreign substance may be evenly or intermittently twisted into the yarn.

Yarn Print'ing Ma-chine'. A machine for printing warps for tapestry carpets. Short's patent, No. 168,932, Oct. 19, 1875. See TAPESTRY CARPET; CARPET LOOM.

Yarn Test'er. An instrument for testing the strength of yarn. See Fig. 2547.

Fig. 2547.

Yarn Tester.

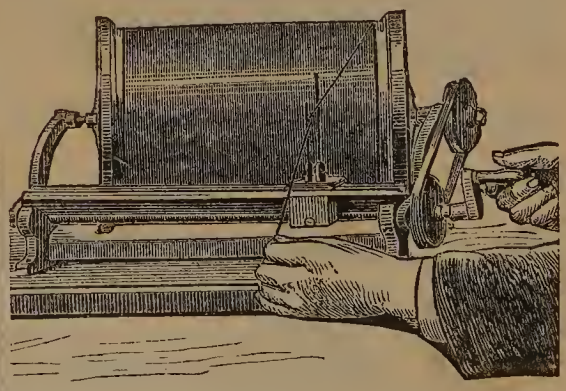
Fasten the foot *a* to the floor, and the legs *d b* to the wall, thus holding the machine firmly in a perpendicular position. Then with a yarn rest, wind from cop or bobbin one knot (or one seventh of a hank or skein) which equals 120 yards. Carefully remove the knot from the reel and place it upon the pins opposite, *g* and *h:* then turn the crank *i* to the right until the yarn breaks. The index point *d* will then show the amount of stretch in inches and eighths, and the upper index *c* will also give the exact breaking weight in pounds avoirdupois.

The machine, shown in Fig. 2548, has for its object the exposure of all unevenness in yarn.

It consists of a black board turned by a strap and pulley from a handle, which latter also revolves a screw, upon which slides a prong-shaped guide for directing the yarn as it comes from the cop, hobbin, or hank. By the revolution of this screw the yarn is wound properly spaced upon the black board, and any unevenness may thus be readily detected, as well as all impurities in the same.

The principle of testing the evenness of the yarn against black boards is not unknown to yarn agents and shippers, but this little apparatus seems to be very handy, and to have the advantage that these boards, with the yarn, may be put aside for ready reference when required.

Fig. 2548.



Yarn Tester.

Yarn Wash'ing Rol'lers. A machine with two cast-iron rollers turned perfectly true and smooth, working on wrought-iron spindles, carried on two cast-iron standards. The pressure is obtained by compound levers and with movable weights, so as to vary the pressure as desired. All the bearings are of gun metal and bored.

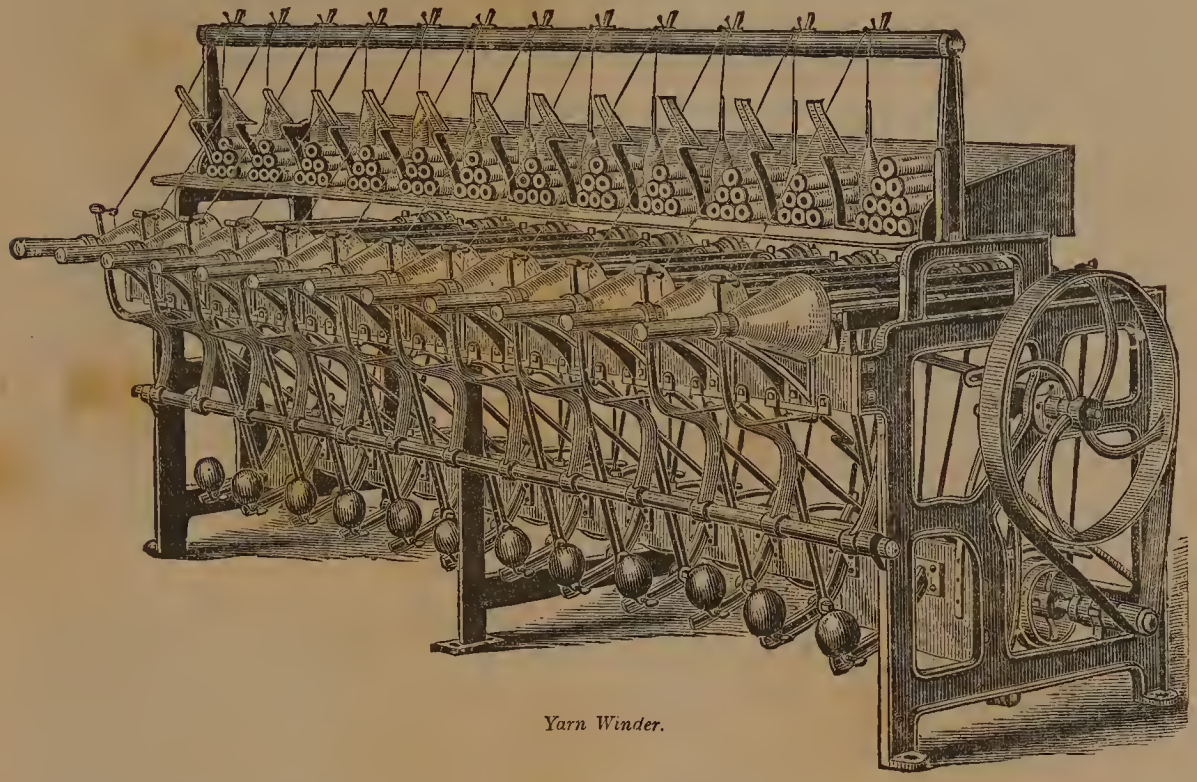
These machines are also fitted up for steam power, with stopping and starting gear.

Yarn Wind'er. Fig. 2549 is Campbell & Clutes' yarn winder for spinning machines.

The yarn is condensed as it is wound on the cone of each bobbin by a glass faced cop-former which leaves the yarn smooth and perfect.

Each sliding bobbin spindle is supported by a sliding journal-box which is at all times close or adjacent to the

Fig. 2549.



Yarn Winder.

base of a bobbin on the spindle so as to prevent the bobbin from shaking and beating upon the cop-former.

Each sliding journal box, with the bobbin spindle and bobbin thereon, is pressed toward the cop former with an adjustable yielding force, by means of a weighted lever having the weight adjustable, so that any desired degree of condensation and solidity can be given to the yarn wound on the bobbin by simply setting the weight to a given point on the lever.

Y Branch. A branch with a divergent stem.

Y Cross. A pipe with two divergent stems.

Yoke. Twin hot and cold water pipes that unite in their discharge, and which have stop cocks that regulate the temperature of the supply.

(*Wheelwright.*) The over-lap tire bolt washer, used at the joints of the felloes.

The arch on which the bell hangs and on whose pivots it swings.

Yt'tri-a. (*Chemical.*) A fine white powder or earth without taste or smell, insoluble in water, and having no effect on vegetable blues. It is supposed to consist of the protoxide of yttrium.

It was discovered by Professor Gadolin in 1794.

Yt'tri-um. A very rare metal discovered in 1828 by Woehler. Its texture is scaly, its color grayish black, and its luster perfectly metallic.

Yt'tro-ce'rite. (*Min.*) A mineral of a violet blue color inclined to gray and white, occurring very sparingly at Finbo and Brodbo, near Fahlun, embedded in quartz. It consists of lime, sesquioxide of cerium, yttria, and hydrofluoric acid.

Yt'tro-tan'ta-lite. (*Min.*) Columbium and yttrium, found in Sweden. It is found of yellow, brown, and black colors.

Z.

Zaf'fer. (*Glass.*) Fr. *zafre, zaffer, saffre:* Sp. *zafore;* It. *zaffera;* Ger. *zaffer.* Impure oxide of cobalt; residuum of treatment of cobalt after impurities are driven off by calcination. Used as blue color in glass-making.

Z Crank. A form of crank especially adapted to use where the minimum of space is one of the most important items of consideration.

The result is a very compact engine of long stroke, the height of the engine being little more than the diameter of the cylinders. In small launches the engine is placed under the smoke-box end of the boiler (locomotive), so that only the space necessary for the latter is required, the engine being in otherwise unused space, and its weight brought to the lowest position possible.

Zinc Dec'o-ra-ting. A chemical process for covering zinc with colored coatings has lately been described by Dr. L. Stille.

The articles of zinc are first brightened by scouring with quartz sand, moistened with dilute muriatic acid, putting them quickly in water and then carefully wiping them dry with white blotting paper. To insure success, however, it is necessary to employ zinc as free as possible from lead, and to have it as bright as a mirror. When these conditions are fulfilled the metal may be coated with a variety of beautiful colors by immersion in a solution of alkaline tartrate of copper for a shorter or longer interval of time, depending on the color that is desired.

Zin'cite. A brittle translucent mineral of a deep red color, sometimes inclining to yellowish, consisting chiefly of oxide of zinc, but containing also a small quantity of oxide of manganese.

Called red zinc ore and red oxide of zinc.

Zinc Coat'ing. On brass or copper.

The following simple process is recommended by Bottger Boil a large excess of so-called zinc dust some time, with a concentrated solution of caustic soda, or potash, and place the copper or brass articles to be coated in the boiling liquid. By continuing the heating, after a few minutes a beautiful, mirror-like film of zinc will form upon them by the decomposition of the alkaline solution, in consequence of their electro-negative character in combination with the zinc. It

is suggested that the process is applicable to the preparation of disks for dry-piles, and also for forming a layer of tombac, by heating a copper article thus coated, carefully, to about 248° to 284° (best under olive oil), when the zinc will unite with the copper support to form a gold-tinted tombac, and the article need only be quickly cooled in water, or some other suitable liquid, as soon as the desired color is apparent.

Zinc Me'thyl. A volatile liquid consisting of two equivalents of carbon, three of hydrogen, and one of zinc. It takes fire spontaneously on exposure to the atmosphere. Its vapors are very poisonous.

Zin'co-graph'ic Cop'y-ing Pro'cess. In the Belgian "*Bulletin du Musée*," M. Hannot describes the following new autographic process: —

The writing or drawing is made upon any kind of paper, which should, however, not be very thick. A special ink is used, composed of gum arabic or gelatine ⅔ oz., water saturated with bichromate of potash, 1 quart, and sufficient India ink to color the whole. The gum is first dissolved in the solution and the ink afterwards added. The preparation must be kept sheltered from the light, and when used a portion should be poured out in an inkstand of black glass. When the drawing is finished it is exposed to light, whereby the lines are rendered insoluble.

A plate of zinc or a stone is then prepared and polished with emery, and the drawing is placed upon it face downward. Above the latter is laid a sheet of paper covered with gum arabic, and above this two or three sheets of dampened blotting paper. The whole is then pressed. The moisture in the blotting paper reaches the gummed paper, and the gum, dissolved, traverses the autographic paper and affects the zinc or stone everywhere except where the insoluble lines of the design have prevented its passage. A roller of greasy ink may then be passed over the plate, and the grease will adhere only to the lines which are not covered with moisture. Printing is then done in the usual way.

Zin-cog'ra-phy. Engraving on zinc in the style of wood-cuts, as also in the use of the lithographic stone, and taking impressions therefrom.

In a paper lately read before the London Society of Arts, by Mr. Thos. Bolas, F. C. S., the following simple process in zincography is described: Zincography, he said, is similar to lithography, except that a zinc plate is employed in the place of the lithographic stone. The so-called transfer paper is merely a moderately fine paper which has been brushed over, on one side, with a mucilaginous mixture, prepared by boiling together the following: Water, 1,000 parts; starch, 100 parts; gamboge, 6 parts; glue, 1 part. This part is written upon with the ordinary commercial lithographic writing ink, which has been rubbed up with water like an artist's water-color. The writing being dry, it is necessary to moisten somewhat the back of the transfer by means of a damp sponge; after which it is laid face downward on a sheet of ordinary roofing zinc, which has been previously cleaned by means of emery cloth. Both being now passed together under the roller of a small press, the transfer adheres to the metal plate; but on damping the back of the paper it becomes easily removable, leaving the writing on the zinc. The face of the zinc plate is now gently rubbed over with mucilage of gum arabic, which is all the better for being slightly sour, and the excess of gum having been sponged off, an india-rubber inking roller, charged with ordinary printer's ink, is passed over the still damp zinc plate a few times. The ink takes only on the lines of the transferred writing, and it is now merely necessary to lay a sheet of white paper on the plate and to pass both through the press to obtain an impression, — an exact reproduction of the original writing.

Any number of copies can be printed by repeating the operations of damping and inking. The zincographic process, thus simplified, is rapid, economical, and within the reach of every one.

Malepeyre . . . . . "*Technologiste*," xxxviii. 26.

Zinc Col'or-ing.

The "*Technologiste*" gives the following process for permanently coloring zinc. The metal must be quite pure, as must also the materials of which the following bath is composed: Tartrate de cuivre, 30 grains; potasse caustique, 40 grains; eau distillée, 400 grains. After being submitted for two minutes to the action of this bath, the zinc takes a violet tint; after three minutes' immersion it becomes a deep blue; in four and a half minutes, green; in six and a half minutes, purple.

The "*Metallarbeiter*" gives the following recipe for giving bright colors to zinc: The objects to be colored are first thoroughly brightened by rubbing with sand and moistening with hydrochloric acid, which is rapidly washed off with water. In order to be successful it is necessary to use zinc free from lead. The colors are produced according to necessity by dipping the object for a certain varying length of time in a solution of tartrate of copper and alkali.

Zinc Pla'ting.

As nickelizing is replacing silvering in some cases, so there are some where nickelizing may be itself replaced for many articles of small value, such as pins, particularly if they contain copper. The manipulation is very simple. Coarse rasped or granulated zinc is boiled for some time in a mixture of three parts by weight of sal-ammoniac and ten of water; the objects are immersed and stirred with a zinc rod. The deposit is silvery bright, and resists mechanical action as well as a coating of nickel. The process can be recommended for goods which are meant for a second coating of some other metal, since any other is easily deposited upon zinc.

Zinc Pow'der.

A powder which is now considerably used in the arts, is said to be composed of zinc, 40 parts; lead, 2.5; cadmium, 4; zinc oxide, 50; zinc carbonate, 2.5, with some traces of non-metallic dust. As a part of the cargo of vessels it is extremely dangerous and ought never to be stowed where it cannot be readily removed. When it is slightly moistened with water it becomes spontaneously inflammable.

Zo'o-gy'ro-scope. A modification and amplification of the zoötrope, in which a series of succeeding instantaneous photographs of an animal (a horse, for instance) in motion are placed on a circular rotating glass, the photographs being alternately illuminated by an oxyhydrogen lantern as the glass turns, throwing a single continuous, yet ever changing, picture upon the screen.

While the separate photographs had shown the successive positions of a trotting or running horse, in making a single stride, the zoögyroscope apparently throws upon the screen the living, moving animal.

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